SURVEY OF DUST-CONTROL PRACTICES IN THE COAL-MINING INDUSTRY

BY R. W. BARNES, M. J. GREGORY, C. W. OWINGS, AND L. B. BERGER

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by

R. W. Barnes,[1] M. J. Gregory,[1] C. W. Owings,[2] and L. B. Berger[3]

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SUMMARY

This circular presents results of a survey conducted by the Bureau of Mines to ascertain the extent to which dust-control practices are employed in the coal-mining industry. This survey was initiated because of increasing realization of the possible harmful effects of the inhalation of dust upon the health of coal-mine workers and the advent, during recent years, of new types of mining machinery and new mining methods that may have a direct effect upon the extent of exposure to airborne dust experienced by persons mining coal.

Anthracite Mines

The survey covered 169 anthracite mines that were operating from November 1, 1953, to July 1, 1954. It showed that large mines employing more than 100 men were doing most to control dust produced during mining.

Control measures were used primarily in drilling, loading, and preparing the coal, and less than half the mines were reported to have been using dust controls on these operations.

Forty-five mines in the anthracite industry employed engineers to study dust hazards and provide means for abating them. Although some controls were used in many mines, much more work remains to be done.

Bituminous-Coal and Lignite Mines

Table 1 summarizes national totals for the primary operations in bituminous-coal and lignite mines - drilling, cutting, loading, and transportation - showing: (1) The number of mines performing an operation of a stated type, and the number and percentage of these mines in which that operation appeared dusty; (2) the number and percentage of mines that used controls to allay dust in a stated operation; and (3) the number and percentage of these mines that appeared dusty.

Review of a few of the most obvious figures presented in table 1 indicates what was being done to control the dust produced in these primary operations.

Drilling

Drilling of the coal face was omitted from table 1(a), as little or nothing was being done to control the dust produced by face drilling, although the coal face was drilled in nearly all mines. Further details are found in the section on drilling (p. 16).

In 15.3 percent of the mines attempts were made to control the dust produced while drilling roof, bottom, or draw slate with rotary drills. Of this number, visible dust was reported in 22.8 percent of the mines. In comparison, 61.9 percent of the mines using percussion drills were equipped with controls, but only 12.0

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percent of these were reported dusty. The higher percentage of controls in percussion drilling mines may be attributed to the greater dust production of percussion drilling, and therefore, the more obvious need for control measures.

Table 1(a) shows that very few controls were used in the class A[4/] (Title I) mines and that class C and D mines had the greatest proportion of controls for drilling. Nearly half the mines not using control measures were reported to have visible dust present during the rock drilling. In many instances where dust was not reported as visible, dust may have been present in harmful concentration. Airborne suspensions of rock dust in amounts that are visible to the unaided eye generally are far above the hygienic limit.

These data bring out the need for more control equipment and greater vigilance in using existing equipment if mine workers are to be protected from exposure to potentially harmful dust. A survey of representative mines in the eastern part of the United States showed the average free silica content of mine roof strata to be 27 percent for shales and 55 percent for sandstone.[5/ 6/] Wet and dry methods of controlling the dust are available, and roof should not be drilled unless adequate control measures are in effect.

Cutting

Coal cutting is one of the dustiest operations involved in coal production. The summary presented in table 1(b) of the national totals again brings out the need for more dust controls and greater operational efficiency of those now in use. Cutting in the bottom of the coal bed usually does not produce as much dust as cutting in other horizons of the bed, but 55 percent of those mines that cut at the bottom and did not use controls were reported to produce visible concentrations of dust. Only 9 percent of the mines that cut in the bottom of the bed used any form of control, and, of those, 49 percent were reported as dusty. A larger proportion of the mines cutting in locations other than the bottom used controls (61 percent), but again these controls appeared far from effective, as 63 percent of these were reported as dusty.

For all types of cutting, those mines using dust control measures made up only 16 percent (derived from data in table 1(b)) of the total. The greater proportion of control measures was used in mines employing over 50 men. Of these mines attempting dust-allaying, only 44 percent were considered successful, on the basis of the observations made.

Loading

Loading coal by machine can produce airborne dust clouds of high concentration. Coal may be loaded in the mine by hand or machine, and in some mines both methods were used. Of the two methods, hand loading produces least dust. Table 1(c) shows that 18 percent of the occurrences of hand loading were dusty and that very few mines (1 percent) attempted to allay dust during hand loading.

4/ Mine classification in respect to number of men employed underground: A = 1 to 14, B = 15 to 49, C = 50 to 99, D = 100 or more.

5/ Westfield, J., Anderson, F. G., Owings, C. W., Harmon, J. P., and Johnson, L., Roof Bolting and Dust Control: Bureau of Mines Inf. Circ. 7615, 1951, 8 pp.

6/ Owings, C. W., and Johnson, L., A Study to Determine Potential Dust Exposure in Connection with Intermittent Rock Drilling in Coal Mines: Bureau of Mines Rept. of Investigations 5004, 1953, 7 pp.

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Only 16 percent of the mines loading coal mechanically had any form of dust-control measures on their loading units, and 65 percent of these were reported to have produced no visible dust. Most of the control measures were used in the larger mines.

Efficient use of existing controls and new controls are needed for loading, as for drilling and cutting, to keep the fine material produced in coal mining from becoming airborne and endangering workmen who operate the machines.

Transportation

As shown in table 1(d), mine cars were by far the most common form of transportation. Very little was being done to control the dust they produced, as only 2.4 percent (table 12) of the mines using mine cars were reported to be wetting the coal in transit. Most mines kept their haulage roads clean and prevented dust from being raised by passing trips. Mine-car haulage can present one of the most hazardous dust conditions in coal mining where grades are steep. High silica traction sand used in most mines, when ground to a fine dust and raised into suspension by passing mine cars, may be a hazard for the men exposed to it.

At any point where coal is dumped or transferred from one form of transportation to another considerable dust is likely to be raised. Dust-control measures were generally confined to these points on transportation systems; 20 percent of the shuttle car installations and 27 percent of the conveyor set-ups were equipped with sprays or other means of wetting the coal as it was dumped or discharged into similar or other forms of transportation. Close to half of these controls appeared effective in keeping the dust from becoming airborne, as judged by visual inspection.

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TABLE 1. - Summary of dust-control measures used during primary mining operations in bituminous-coal and lignite mines

(a) Drilling other than coal-face

Drill type	Mine class[1]	All mines			Mines using controls			
			Visible dust[2]				Visible dust[2]	
		Number	Number	Percent	Number	Percent	Number	Percent
Rotary	A	227	103	45.4	4	1.8	0	0.0
	B	133	55	41.4	7	5.2	1	14.3
	C	75	42	56.0	10	13.3	1	10.0
	D	224	115	51.3	80	37.4	21	26.3
		659	315	47.8	101	15.3	23	22.8
Percussion	A	39	21	53.8	4	10.3	0	0.0
	B	64	38	59.4	21	32.8	4	19.0
	C	89	37	41.6	48	53.9	4	8.3
	D	333	86	25.8	252	75.7	31	12.3
		525	182	34.7	325	61.9	39	12.0

(b) Cutting

Type of cutting	Mine class[1]	All mines			Mines using controls			
			Visible dust[2]				Visible dust[2]	
		Number	Number	Percent	Number	Percent	Number	Percent
Bottom	A	932	487	52.3	33	3.5	16	48.5
	B	427	233	54.6	31	7.3	18	58.1
	C	180	120	66.7	25	13.9	15	60.0
	D	287	167	58.2	79	27.5	33	41.8
		1,826	1,007	55.1	168	9.2	82	48.8
Other than bottom	A	26	12	46.2	5	19.2	3	60.0
	B	61	44	72.1	24	39.3	17	70.8
	C	38	29	76.3	24	63.2	17	70.8
	D	165	104	63.0	123	74.5	73	59.3
		290	189	65.2	176	60.7	110	62.5

(c) Loading

Type of loading	Mine class[1]	All mines			Mines using controls			
			Visible dust[2]				Visible dust[2]	
		Number	Number	Percent	Number	Percent	Number	Percent
Hand loading	A	2,056	343	16.7	11	0.5	1	9.1
	B	374	74	19.8	3	.8	0	.0
	C	87	25	28.7	4	4.6	0	.0
	D	100	30	30.0	7	7.0	0	.0
		2,617	472	18.0	25	1.0	1	4.0
Mechanical loading	A	120	49	40.8	12	10.0	3	25.0
	B	145	52	35.9	13	9.0	3	23.1
	C	113	53	46.9	16	14.2	7	43.8
	D	281	137	48.8	66	23.5	24	36.4
		659	291	44.2	107	16.2	37	34.6
Hand and mechanical loading	A	8	4	50.0	0	0.0	0	0.0
	B	16	6	37.5	4	25.0	1	25.0
	C	25	13	52.0	2	8.0	1	50.0
	D	76	32	42.1	14	18.4	6	42.9
		125	55	44.0	20	16.0	8	40.0

(d) Transportation

Type of transportation	Mine class[1]	All mines			Mines using controls			
			Visible dust[2]				Visible dust[2]	
		Number	Number	Percent	Number	Percent	Number	Percent
Mine cars	A	2,115	105	5.0	6	0.3	1	16.6
	B	485	22	4.5	6	1.2	1	16.6
	C	205	16	7.8	11	5.4	1	9.1
	D	432	55	12.7	56	13.0	6	10.7
		3,237	198	6.1	79	2.4	9	11.4
Shuttle cars	A	73	19	26.0	3	4.1	3	100.0
	B	77	22	28.6	10	13.0	4	40.0
	C	92	38	41.3	19	20.7	11	57.9
	D	247	91	36.8	66	26.7	37	56.1
		489	170	34.8	98	20.0	55	56.1
Conveyors	A	132	48	36.4	8	6.1	6	75.0
	B	118	46	39.0	17	14.4	11	64.7
	C	77	36	46.8	24	31.2	12	50.0
	D	174	74	42.5	86	49.4	45	52.3
		501	204	40.7	135	26.9	74	54.8

1/ Mine classes A = 1-14 men underground.
B = 15-49 men underground.
C = 50-99 men underground.
D = 100 or more men underground.

2/ Visible dust: Dust reported on questionnaire as visible to unaided eye.

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INTRODUCTION

Background of Survey

Health of miners was one of the primary considerations of the Bureau of Mines when it was organized in 1910. At that time serious conditions existed in some western metal-mining districts. The first director of the Bureau of Mines, Dr. J. A. Holmes, instituted preliminary surveys of dust and ventilation in some of these mines in 1913, assisted by Dr. S. C. Hotchkiss of the United States Public Health Service. These investigations showed that pneumoconiosis was widespread in certain mining districts.

The first investigation of silicosis in the mining industry in the United States was made in 1914-15 by the Bureau of Mines in cooperation with the United States Public Health Service in the Joplin (Mo.) mining district.7/

This study demonstrated definitely the harmful effects of breathing siliceous mine dust, and recommendations were made for relieving such conditions. This field work was continued8 9/ in the following year, including the first detailed X-ray studies of silicosis made in the United States, and the resulting recommendations did much to improve conditions with respect to exposure to airborne dust in the mines and led to the adoption of legislation to help protect the health of mine workers.

In 1916 investigations of "miners' consumption" were begun in the copper mines of the Butte district of Montana.10/ These investigations, lasting for 3-1/2 years, resulted in recommendations, which, when put into effect, directed attention to preventing pneumoconiosis in those areas. Dust and ventilation studies were made in 1919-20 by G. E. McElroy and Dr. R. A. Koronski of the U. S. Public Health Service in the copper-mining district of Arizona, and in the following year similar studies were made by Bureau of Mines engineers and U. S. Public Health Service surgeons in other metal mining districts of the West.

In 1923 dust and ventilation studies were conducted in Alabama ore and coal mines by J. J. Forbes and D. Harrington of the Bureau of Mines and F. V. Meriwether and F. Flinn, surgeons of the U. S. Public Health Service. This study, the first of its kind and extent to be conducted in United States coal mines, demonstrated that coal miners also were subject to pneumoconiosis. Other studies of the effects of exposure to coal-mine dust have developed much additional information.11 12 13/

7/ Lanza, A. J., and Higgins, Edwin, Pulmonary Disease Among Miners of the Joplin District, Missouri, and Its Relation to Rock Dust in the Mines: Bureau of Mines Tech. Paper 105, 1915, 48 pp.

8/ Higgins, Edwin, Lanza, A. J., Laney, F. B., and Rice, G. S., Siliceous Dust in Relation to Pulmonary Disease Among Miners in the Joplin District, Missouri: Bureau of Mines Bull. 132, 1917, 116 pp.

9/ Lanza, A. J., and Childs, S. B., I. Miners' Consumption: A Study of the Disease Among Zinc Miners in Southwestern Missouri. II. Roentgen-Ray Findings in Miners' Consumption: U. S. Public Health Bull. 85, 1917, 40 pp.

10/ Harrington, D., and Lanza, A. J., Miners' Consumption in the Mines of Butte, Mont.: Bureau of Mines Tech. Paper 260, 1921, 19 pp.

11/ Sayers, R. R., Bloomfield, J. J., DallaValle, J. M., Jones, R. R., Dreessen, W. C., Brundage, D. K., and Britten, R. H., Anthraco-Silicosis Among Hard-Coal Miners: U. S. Public Health Bull. 221, 1935, 114 pp.

12/ Flinn, R. H., Seifert, H. E., Brinton, H. P., Jones, J. L., and Franks, R. W., Soft-Coal Miners Health and Working Environment: U. S. Public Health Bull. 270, 1941, 118 pp.

13/ Doyle, H. N., and Noehren, T. H., Pulmonary Fibrosis in Soft-Coal Miners: U. S. Public Health Bibliography Ser. 11, Pub. 352, 1954, 59 pp.

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Since 1930 the Bureau of Mines has conducted many investigations dealing with dust conditions in mines and has issued numerous publications describing the hazards of exposure to dust atmospheres and presenting recommendations for controlling them.14 15 16 17 18 19 20 21 22 23 24/ As a result of this work, many mines have adopted the use of dust-controlling devices and dust-allaying systems.

Coal dust is a hazard both from explosion and health standpoints. Dense clouds of dust restrict visibility and cause personal discomfort of men who must work in them. Breathing high concentrations of coal or rock dust contributes to inflammation and infection of the respiratory tract and may eventually lead to pneumoconiosis. Bituminous-coal dust raised into suspension by mining operations is carried by the ventilating current and settles on mine surfaces, increasing the explosion hazard and making it necessary to apply rock dust in such proportion that the mixture will not propagate an explosion if again thrown into suspension in the air. If this coal dust were allayed at the source and prevented from becoming airborne, it is evident that the benefits that could result in the form of safer, more healthful working conditions and a general increase in worker efficiency would more than offset the expense incurred in studying and applying dust-allaying and controlling devices.

Purpose of Survey

To ascertain the extent to which industry controls dust in coal mines, in 1953 the Bureau of Mines conducted a survey by questionnaire to determine the extent to which dust-control practices were being used and how effective they were.

14/ Harrington, D., Dust Hazards and Their Control in Mining: Bureau of Mines Inf. Circ. 6954, 1937, 7 pp.

15/ Littlefield, J. B., Feicht, F. L., and Schrenk, H. H., Bureau of Mines Midget Impinger for Dust Sampling: Bureau of Mines Rept. of Investigations 3360, 1937, 4 pp.

16/ Harrington, D., Forbes, J. J., Cash, F. E., Denny, E. H., Herbert, C. A., Parker, D. J., Owings, C. W., and Miller, A. U., Allaying Dust in Bituminous-Coal Mines With Water: Bureau of Mines Tech. Paper 593, 1939, 55 pp.

17/ Hartmann, I., and Greenwald, H. P., Use of Wetting Agents for Allaying Coal Dust in Mines: Bureau of Mines Inf. Circ. 7131, 1940, 12 pp.

18/ Sayers, R. R., Pulmonary Diseases in the Mining Industry: Bureau of Mines Inf. Circ. 7146, 1941, 26 pp.

19/ Owings, C. W., Some Preliminary Data on Methods for Controlling the Dust Hazards in Mechanical Mining: Bureau of Mines Inf. Circ. 7151, 1941, 12 pp.

20/ Owings, C. W., Methods of Allaying Dust in Underground Mining Operations: Bureau of Mines Rept. of Investigations 3631, 1942, 38 pp.

21/ Kingery, D. S., Some Preliminary Data on Methods for Allaying Coal Dust in Tipples and Cleaning Plants: Bureau of Mines Inf. Circ. 7248, 1943, 11 pp.

22/ Owings, C. W., Suggested Methods for Installing Dust-Allaying Equipment in Bituminous-Coal Mines: Bureau of Mines Rept. of Investigations 3843, 1945, 31 pp.

23/ Johnson, L. H., Dust Problems in the Mines of the Pennsylvania Anthracite Region: Bureau of Mines Tech. Paper 704, 1947, 34 pp.

24/ Westfield, J., Anderson, F. G., Owings, C. W., Harmon, J. P., and Johnson, L., Roof Bolting and Dust Control: Bureau of Mines Inf. Circ. 7615, 1951, 8 pp.

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Survey Method

The survey was based upon information gathered especially to analyze dust-control practices. To cover all coal mines in the country in a relatively short time, the Federal coal-mine inspectors were instructed to obtain specific information as they made their regular inspection and to record this information in a special questionnaire (see Appendix E) to be filled out for each mine as it was inspected.

The inspectors were not required to determine or to estimate the concentration of airborne dust in the mines inspected. The only measure made of air dustiness was the observation of whether or not airborne dust was visible, on the assumption that the presence of dust in visible concentration is reasonable evidence that particles of respirable sizes probably are present in excessive amount. Therefore, throughout this report the differentiation of mines or conditions on the basis of visible dust is intended only as a record of an incidental observation rather than an accurate estimation or evaluation of relative air dustiness in respect to possible effects on health. The questionnaire was designed to be answered primarily by check marks or a simple "yes" or "no" to avoid personal opinions as much as possible.

Each mining operation was taken separately; its method of operation and any methods for controlling the dust produced were recorded. In general, the answers obtained seemed to give a clear picture of the operation when the inspection was made.

Discussion of Questionnaire

As the results obtained by circulating any type of questionnaire can be no better than the form or manner in which the questions are asked, the functioning of this questionnaire was analyzed as replies were received.

A few weak points were detected in the questionnaire that should be corrected if future surveys are conducted. A question under drilling was whether water had been applied during drilling to control the dust. This was misunderstood in a number of instances to mean that the drilling was or was not being done in a wet place.

No correlation was asked for between the amount of roof drilling and the number of roof bolts installed; therefore, the proportion of roof drilling done for roof bolting could not be determined.

Under Coal Cutting the exact method of cutting the coal face could not be determined. A large mine might use all the cut-locations shown in the questionnaire and in different combinations in different parts of the mine. If all the locations were checked there was no way to establish what combination of cut-positions was used and what control measures were used on each.

A question in the next section, Blasting, asked if the place was wetted before blasting. This was taken to mean, variously, that the place was naturally wet, that it was wetted during cutting, or that it was deliberately wetted immediately before blasting.

Under Transportation and Loading a question asked if loaded material was wetted before or during loading or transportation: If the answer to this were yes, there was no way of deciding whether it was meant to mean before the operation, during the operation, or both.

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In general, the questionnaire did not ask for enough detail or provide enough space for information on dust-control equipment in use, so that the relative effectiveness of the types could be compared.

The questionnaire did not mention the high-silica sand dust on haulage roads, and no information regarding the exposure of workmen to this hazard was obtained. However, this rather controversial subject probably would be best resolved by extensive sampling of actual mine atmospheres rather than by observation or opinion.

A few inspectors apparently took the entire questionnaire to be based upon a desire to obtain information on dust in respect to the explosion hazard rather than to the health standpoint for which it was intended.

On the last page of the questionnaire a space was provided for additional remarks about any unusual dust-control methods observed. Almost no information was obtained in this space. Presumably, either every mine uses standard dust-allaying and controlling devices, or this section was overlooked because of its location in the questionnaire.

All things being considered, the questionnaire form used gathered a large quantity of valuable information even though a few points of interest were missed.

Number of Mines Surveyed

The survey covered 3,413 bituminous-coal and lignite mines and 169 anthracite mines, representing all mines that were operating from November 1, 1953, to July 1, 1954, except for a few small "wagon" mines operated too sporadically to be inspected during this period.

ACKNOWLEDGMENTS

Circulation of the questionnaire used to obtain the information presented in this report was authorized by J. J. Forbes, Director, and James Westfield, Assistant Director - Health and Safety, of the Bureau of Mines. The data of the survey were collected by the Federal coal-mine inspectors of the Division of Coal-Mine Inspection. These men were selected because they provided the most practicable means by which the coal mines in the United States could be covered in a reasonably short period. The authors wish to express their sincere appreciation for the interest and cooperation of all concerned and particularly for the work done by the coal-mine inspectors, which was additional to their regular duties.

EXPLANATION OF TABLES

The tables presented for the anthracite mines contain the data on dust control for drilling, blasting, loading, and transportation. Information on other operations is presented in the text. These tables show the use and relative effectiveness of dust controls and the number of and dust conditions of mines where controls were not used.

The States in which the bituminous-coal and lignite mines are situated are arranged in decreasing order of daily coal production. West Virginia is the leading producer and has been divided into Northern West Virginia and Southern West Virginia. Northern West Virginia includes all the northern part of the State and extends south to the Kanawha field on the west and to the Webster-Gauley field on the east. Southern West Virginia includes these two fields and all the area of the State south of them. The State was divided in this manner because the characteristics of the

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coal beds in the two areas vary widely, and the equipment and mining practices vary with the beds. Another outstanding difference between the two areas is the size of the mines. Few small mines are operated in the southern part of the State, but in the northern section they are abundant.

Arkansas, Oklahoma, Washington, and Wyoming are grouped together in Group I, and Iowa, Maryland, Missouri, Montana, and New Mexico are assembled in Group II. The data from these States are combined because all are relatively small coal producers and individual mines might be identifiable in some of the tables. Georgia, Kansas, and North Dakota had 9 active mines with a total employment of 101 men. Since these States used no control measures, they were excluded from the tables.

The mines have been classified according to size in each State. The Federal Coal-Mine Safety Act divides coal mines into two size groups; Title I includes all mines in which not more than 14 men are employed underground, and Title II includes mines that employ 15 or more men underground. In assembling the data, it was found that Title II mines divided readily into three groups. In the tables, each size group has been assigned a letter, as follows:

Class of mine	Men employed underground	
A	1-14	Title I
B	15-49	Title II
C	50-99	Title II
D	100 or more	Title II

The first part of each table shows the State-by-State data for the operation being reported for the mines in each employment class. The second part of each table shows the national totals for each phase of the operation being reported for each employment class. The table also shows the number and percentage of mines in each category in which visible dust was reported. In some instances an operation was reported as being done in more than one way in the same mine; therefore, the number of operations or occurrences of an operation do not always equal the total number of mines covered by the survey.

Each table is accompanied by an explanation of the main points of the table and a discussion of the factors involved in the amount and control of dust produced by the operation under consideration.

DUST CONTROL IN THE ANTHRACITE INDUSTRY

The mines and mining systems in the anthracite industry differ widely from those in the bituminous-coal-producing areas. The steeply pitching coal measures, the faulting of the strata, and the character of the coal make it impossible to apply many systems used in bituminous mining. The coal tonnage produced per man employed underground is lower in most anthracite mines than in comparable bituminous-coal mines because of difficult mining conditions in the anthracite field.

These anthracite mines produced 94,492 tons of coal daily. A total of 169 mines was operating at the time of this survey, employing 27,739 men underground.

Generally, the anthracite industry is extremely dust conscious and has done much to control dust produced in mining operations. Because of the systems of mining, much work is done in solid rock, and the pneumoconiosis hazard is greater than for work done primarily in coal. Pneumoconiosis has been contracted in the past by men working in the anthracite mines.25/ The number of disabled miners has

25/ See work cited in footnote 11, p. 5.

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been steadily decreasing, but dust-control work remains to be done, as this survey shows. More and better systems of dust control are needed, and the use of existing systems and devices must be made more efficient if the hazard of pneumoconiosis is to be eliminated.

Face Drilling

Nearly every available method was used to drill the coal face throughout the anthracite mines, but rotary drilling without dust control made up about 60 percent of the face drilling. Of those occurrences, 37 percent were reported dusty. Only 8 of 115 mines used controls on rotary face drilling, and these controls were effective in all but 1 mine.

Percussion drilling of the face was practiced to a lesser extent than rotary drilling, and again controls generally were not used; 16 percent of the percussion drills were equipped with controls. Water was the most effective control medium, as no dust was reported in any of the 10 instances where it was used. About 60 percent of the dust collectors were not effective, as 3 out of 5 were reported to allow escape of visible dust.

Rock Drilling

The dust produced by drilling rock is far more hazardous to breathe than that produced by drilling coal because of its high silica content. Most rock drilling (75 percent) was done by percussion machines. The most widely used method of controlling the dust produced by these drills was to apply water, which appeared effective in all but one instance. Only 13.6 percent of the percussion drill set-ups were equipped with dust collectors, and 70 percent of these were reported to allow escape of visible dust; 50 percent of the percussion drilling occurrences had no controls, and of these 76.5 percent were reported to produce visible dust.

In rock, rotary drilling was practiced to a lesser extent than percussion drilling. Very few controls were in use on these machines; only 13 percent were equipped with collectors or used water. In the mines that did not use controls for rotary drilling about half were found to produce visible dust.

It must be borne in mind that these data were based on the coal-mine inspectors' visual observations, and that a lack of visible dust does not necessarily mean that no dust was present. Harmful concentrations of airborne mineral dusts may be present but invisible to the unaided eye. The term "visible dust" may represent a rather extreme case.

It is evident that many installations of both rotary and percussion drills in the anthracite mines needed some form of dust control.

Cutting

Little cutting is done in the anthracite mines, as frequently the coal beds are steeply pitching, and cutting machines cannot be used. Only eight of the mines investigated (all Class D) cut coal, and each of these used bottom-cutting machines. Controls to allay the dust were employed in 4 of these, and only 2 were reported to produce no visible dust. The mines that did not cut the coal blasted it from the solid face.

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Blasting

Most anthracite mines used permissible explosives, but a few used dynamite in rock headings.

All blasting was done by State-certified miners, and the larger part of the blasting was done on shift, but a few mines in each size class shot at the end of the shift or off-shift.

Many (40 percent) of the Class D mines wetted the coal after it was blasted to help allay the dust produced when this coal was loaded. A few of the smaller mines (Classes A, B, and C) wetted the coal before blasting, after blasting, or both.

Thirteen class D mines were reported to have dust and smoke present when men returned after blasting; five class B and C mines also were reported to have this condition. However, ventilation was good in most mines, and in the instances mentioned the men probably returned to the places too quickly.

Loading

Hand loading was practiced extensively in both small and large mines. Mechanical-loading units were used only where seam conditions permitted. Relatively little visible dust was reported to be produced during loading in class A, B, or C mines. The greatest number of dusty operations was found in the class D mines that loaded the coal by both hand and mechanical means. The absence of visible dust in the class A, B, and C mines probably was a result of the natural wetness of many of the mines and the application of water to the coal both before and during loading in the others. Most of the control measures used during loading were reported in class D mines. (See figs. 1 and 2.)

Transportation

Mine cars and conveyors were found to be essentially the only form of transportation used in the anthracite mines. One mine used shuttle cars, and, although there was no dust control, dust was not reported.

About one-fourth of the mine cars used in class D mines were dusttight. In the other 3 classes of mines 15 percent of the mine cars used were dusttight. Few cars were found to be overloaded, and only two mines were reported to have atmospheric dust visible on haulageways. Most haulage roads were kept clean and many were naturally wet, which kept most of the dust out of the air. The coal was wetted in transit in 10 mines.

Sixty-six conveyor installations were in use, but only three mines used any form of dust control in conjunction with them. Only 8 occurrences of visible dust were reported, 1 of which was an installation where controls were used.

Ventilation

All mines except three used mechanical ventilation. The air was carried to the face in the majority of these mines, and in the remainder ventilation was carried at least to the last crosscut. In general, ventilation was good for all classes of mines.

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Figure 1. - Loading coal into car from conveyor without using water.

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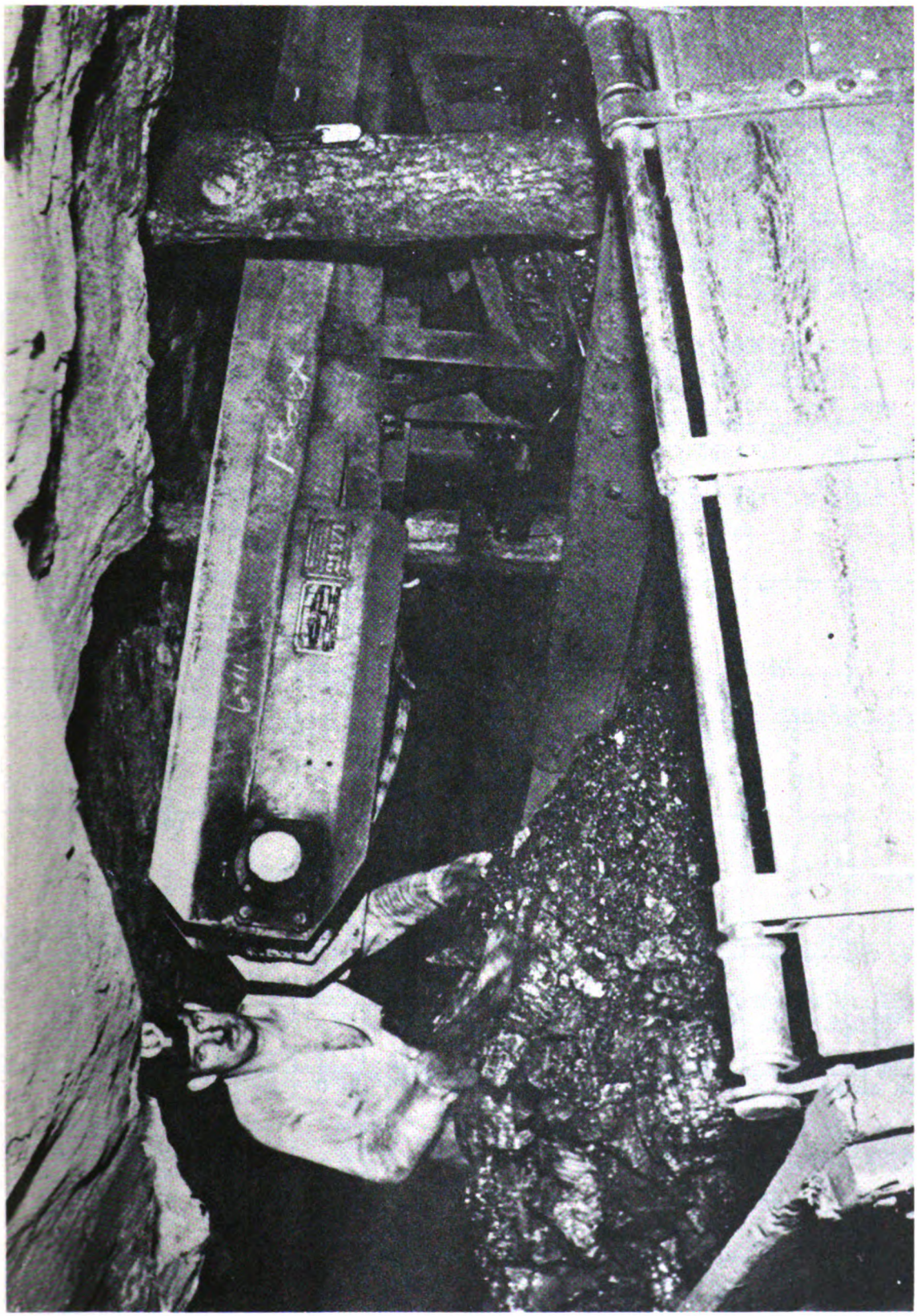

Figure 2. - Loading coal into car from conveyor using water to allay the dust (same working place as in fig. 1).

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Tipples and Cleaning Plants

Over half the class D mines were reported to use dust-control measures on tipples or cleaning plants. A few of the other mines used dust-control measures. Of 12 installations in class A, B, and C mines, only 3 were reported to need more controls or have controls that were not effective. Of the class D mines using controls, 36 percent were considered by the inspectors to need more controls or more effective application of those in use.

Some of the smaller mines did not use controls, but the only point at which dust was reported was at the dump. Other small mines and some large mines that did not use controls had no visible dust, so it is assumed that the coal was too wet to produce dust.

Dust-Control Engineers

The anthracite industry employs more men to study dust conditions and dust-control practices than the bituminous industry. A total of 45 mines in 12 different companies were reported as having dust-control engineers or men that did this work. All these mines were reported to conduct dust surveys.

TABLE 2. - Use and relative effectiveness of dust-control practices in anthracite mines, by mine class, during drilling (face, roof, bottom, and draw slate)

Type of drilling	Mines		Dry-drilling occurrences						Wet-drilling occurrences		
			No controls			Dust collector					
				Visible dust			Visible dust			Visible dust	
	Class[1/]	Number	Number	Number	Percent	Number	Number	Percent	Number	Number	Percent
Rotary	A	31	30	5	16.6	1	0	0	0	0	0
	B	50	45	12	26.7	-	-	-	1	0	0
	C	21	19	5	26.3	-	-	-	-	-	-
	D	67	58	38	65.5	4	1	25.0	9	2	22.2
		169	152	60	39.5	5	1	20.0	10	2	20.0
Percussion	A	31	12	7	58.3	2	2	100.0	1	0	0
	B	50	33	16	48.5	4	3	75.0	6	0	0
	C	21	13	7	53.8	1	1	100.0	2	0	0
	D	67	90	70	77.8	8	4	50.0	59	1	1.7
		169	148	100	67.6	15	10	66.7	68	1	1.5
Rotary and percussive drilling		169	300	160	53.3	20	11	55.0	78	3	3.8

1/ Mine classes: A = 1-14 men underground, B = 15-49, C = 50-99, D = 100 or more.

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TABLE 3. - Extent of applying water before and after blasting in anthracite mines, by mine class

Mines		Wetted						Naturally wet	
		After blasting		Before blasting		Before and after blasting			
Class[1/]	Number	Number	Percent	Number	Percent	Number	Percent	Number	Percent
A	31	1	3.2	0	0	0	0	0	0
B	50	2	4.0	1	2.0	2	4.0	2	4.0
C	21	2	9.5	0	0	2	9.5	1	4.8
D	67	27	40.3	0	0	6	9.0	0	0
	169	32	18.9	1	0.6	10	5.9	3	1.8

1/ Mine classes: A = 1-14 men underground, B = 15-49, C = 50-99, D = 100 or more.

TABLE 4. - Use and relative effectiveness of dust-control measures during loading in anthracite mines, by mine class and loading practice

Type of loading	Mines		Controls used			No controls used		
				Visible dust			Visible dust	
	Class[1/]	Number	Number	Number	Percent	Number	Number	Percent
Hand	A	31	-	-	-	22	0	0
	B	50	1	0	0	20	5	25.0
	C	21	2	0	0	8	1	12.5
	D	67	2	0	0	16	6	37.5
		169	5	0	0	66	12	18.2
Mechanical	A	31	-	-	-	1	0	0
	B	50	-	-	-	7	1	14.3
	C	21	-	-	-	1	0	0
	D	67	2	0	0	8	0	0
		169	2	0	0	17	1	5.9
Hand and mechanical	A	31	-	-	-	8	0	0
	B	50	2	1	50.0	20	4	20.0
	C	21	-	-	-	10	0	0
	D	67	13	3	23.1	26	12	46.2
		169	15	4	26.7	64	16	25.0
All loading		169	22	4	18.2	147	29	19.7

1/ Mine classes: A = 1-14 men underground, B = 15-49, C = 50-99, D = 100 or more.

TABLE 5. - Extent of dust-control practices in relation to mine cars, coal in transit, and main-line haulage roads in anthracite mines, by mine class

Mines		Tight cars, number mines	Overloaded cars, number mines	Wetted cars, number mines	Naturally wet haulageways	Cleaned haulageways	Wetted haulageways
Class[1/]	Number						
A	31	4	0	1	5	28	0
B	50	9	1	2	18	38	0
C	21	3	0	1	10	13	1
D	67	15	6	6	23	55	2
Totals	169	31	7	10	56	134	3

1/ Mine classes: A = 1-14 men underground, B = 15-49, C = 50-99, D = 100 or more.

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DUST CONTROL IN THE BITUMINOUS-COAL AND LIGNITE INDUSTRY

Drilling

The Federal Mine Safety Code of 1953 for underground bituminous-coal and lignite mines states in Article IX, Section 1b, "The dust from drilling rock shall be controlled by the use of permissible dust collectors or by water or water with a wetting agent."

It has long been recognized that exposing workmen to siliceous airborne dust produced by rock drilling may be harmful. This exposure, however, may be greatly reduced if precautions are taken to collect or otherwise control this dust before it becomes airborne and is breathed by the workmen. From the data in table 6 it may be concluded that this was not being done in the majority of mines.

Drilling is done in United States coal mines for blasting or roof bolting. The equipment used for drilling falls into two main classes; percussion and rotary. Percussion drills are operated pneumatically and generally are of the stoper or jackhammer types. Rotary drills generally are driven by electric or hydraulic motors. In some small mines hand-powered augers still are used; these are turned at such a slow speed that little dust is produced.

Pneumatic percussion drilling is a very dusty operation if there is no means of collecting or controlling the dust. The chief methods of dust control are water and dust collectors. Water is introduced through the drill steel and wets most of the cuttings as they are formed. Dust collectors can catch much of the dust and cuttings and prevent them from being disseminated into the air.

Rotary drilling need not be as dusty as percussion drilling. Hydraulically operated and controlled drills can be regulated to give high bit pressure and slower rotational speed, thus producing a high rate of penetration and less fine dust. Hand-held hydraulic drills and electric units do not have this advantage and may produce considerable dust. Dust collectors may be used for rotary drills in the same manner as for percussion drills, but if water is used during rotary drilling, it usually is sprayed on the cuttings as they emerge from the hole. Water used in percussion drilling usually controls the dust well, but on rotary units the fine dust is already in suspension and a water spray around the collar of the hole serves only to suppress the larger particles. Water is also introduced through the steel as in percussion drilling. A Bureau of Mines approved dust collector can keep the dust concentration in the breathing zone of the driller below 10 million particles per cubic foot of air if the device is properly maintained and is used in the manner for which approval was granted.

Face Drilling

Drilling the coal face preparatory to placing explosives or other coal-breaking devices throws little dust into suspension in small mines where hand augers are used; but, where high-speed electric or hydraulic drills are used, high concentrations of dust can be produced. Factors affecting the production of dust are: The drill speed, the height of the hole above the bottom, the sharpness and type of the drill bit, and the moisture content of the coal. Those mines that did not drill in the face either did all the work by hand or employed one of the continuous-type mining machines requiring no blasting.

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TABLE 6. - Use and relative effectiveness of dust-control measures during drilling in bituminous-coal and lignite mines. A: By States and mine class

State	Mines: Class mines 1/	Mines: Number	Face drilling: Rotary drilling: No controls: Number	Face drilling: Rotary drilling: No controls: Visible dust	Face drilling: Rotary drilling: Controls: Number	Face drilling: Rotary drilling: Controls: Visible dust	Face drilling: Percussion dry no control: Number	Face drilling: Percussion dry no control: Visible dust	Face drilling: Total mines power drilling: Number	Face drilling: Total mines power drilling: Visible dust	Face drilling: Hand drilling	Face drilling: No drilling	Roof drilling: Rotary drilling: No controls: Number	Roof drilling: Rotary drilling: No controls: Visible dust	Roof drilling: Rotary drilling: Dry with collector: Number	Roof drilling: Rotary drilling: Dry with collector: Visible dust	Roof drilling: Rotary drilling: Wet: Number	Roof drilling: Rotary drilling: Wet: Visible dust	Roof drilling: Rotary drilling: Total: Number	Roof drilling: Rotary drilling: Total: Visible dust	Roof drilling: Percussion drilling: No controls: Number	Roof drilling: Percussion drilling: No controls: Visible dust	Roof drilling: Percussion drilling: Dry with collector: Number	Roof drilling: Percussion drilling: Dry with collector: Visible dust	Roof drilling: Percussion drilling: Wet: Number	Roof drilling: Percussion drilling: Wet: Visible dust	Roof drilling: Percussion drilling: Total: Number	Roof drilling: Percussion drilling: Total: Visible dust
West Virginia (Northern)	A	171	94	6	-	-	-	-	94	6	74	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B	79	62	14	-	-	-	-	62	14	17	-	3	3	-	-	-	-	3	3	6	6	4	2	-	-	10	8
	C	18	14	4	-	-	-	-	14	4	4	-	-	-	-	-	-	-	-	-	2	2	4	1	-	-	6	3
	D	27	25	10	1	0	-	-	26	10	1	-	-	-	3	0	9	5	12	5	-	-	10	4	2	2	12	6
West Virginia (Southern)	A	39	36	7	-	-	-	-	36	7	3	-	1	0	-	-	-	-	1	0	-	-	-	-	-	-	-	-
	B	76	68	9	-	-	1	0	69	9	7	-	3	3	1	1	-	-	4	4	4	2	4	0	1	0	9	2
	C	61	59	19	-	-	-	-	59	19	2	-	6	3	2	1	-	-	8	4	4	3	6	1	5	0	15	4
	D	148	143	33	-	-	1	0	144	33	4	-	17	13	7	1	3	0	27	14	9	7	38	6	36	1	83	14
Pennsylvania	A	280	234	47	1	0	-	-	235	47	42	3	13	9	-	-	-	-	13	9	4	4	-	-	-	-	4	4
	B	103	80	20	-	-	-	-	80	20	21	2	12	7	-	-	-	-	12	7	4	2	-	-	-	-	4	2
	C	31	28	12	-	-	-	-	28	12	3	-	7	3	3	0	-	-	10	3	3	2	1	0	-	-	4	2
	D	95	89	41	2	1	-	-	91	42	3	1	11	10	9	0	1	0	21	10	12	10	27	2	6	1	45	13
Kentucky	A	416	403	133	-	-	-	-	403	133	12	1	45	31	-	-	-	-	45	31	4	3	-	-	-	-	4	3
	B	114	113	38	-	-	-	-	113	38	1	-	29	11	2	0	-	-	31	11	3	3	1	0	1	0	5	3
	C	49	47	18	-	-	1	1	48	19	-	1	8	7	1	0	-	-	9	7	10	10	2	0	-	-	12	10
	D	62	60	21	1	0	-	-	61	21	1	-	16	10	5	3	5	0	26	13	8	6	11	3	8	1	27	10
Illinois	A	15	15	10	-	-	-	-	15	10	-	-	4	3	-	-	-	-	4	3	-	-	-	-	-	-	-	-
	B	11	10	10	-	-	-	-	10	10	1	-	2	2	-	-	-	-	2	2	-	-	-	-	-	-	-	-
	C	4	4	4	-	-	-	-	4	4	-	-	3	3	-	-	-	-	3	3	-	-	-	-	-	-	-	-
	D	30	29	25	-	-	-	-	29	25	-	1	17	16	1	0	1	1	19	17	2	2	-	-	-	-	2	2
Virginia	A	298	289	14	-	-	-	-	289	14	9	-	8	1	-	-	-	-	8	1	4	3	-	-	-	-	4	3
	B	44	42	4	-	-	-	-	42	4	2	-	6	3	1	0	-	-	7	3	6	5	-	-	-	-	6	5
	C	12	11	4	-	-	-	-	11	4	1	-	2	2	1	0	-	-	3	2	2	2	2	0	-	-	4	2
	D	22	22	2	-	-	-	-	22	2	-	-	5	2	4	2	1	0	10	4	2	2	4	1	1	0	7	3
Alabama	A	178	165	24	-	-	-	-	165	24	12	1	33	21	0	-	-	-	33	21	6	4	-	-	-	-	6	4
	B	14	12	3	-	-	-	-	12	3	1	1	3	1	0	-	-	-	3	1	2	1	-	-	1	0	3	1
	C	8	8	3	-	-	-	-	8	3	-	-	2	1	0	-	-	-	2	1	2	1	-	-	2	0	4	1
	D	18	18	5	-	-	-	-	18	5	-	-	2	1	1	0	-	-	3	1	1	1	7	0	4	0	12	1
Ohio	A	166	155	82	-	-	-	-	155	82	11	-	3	1	-	-	-	-	3	1	-	-	-	-	-	-	-	-
	B	27	21	10	1	0	-	-	22	10	5	-	1	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-
	C	4	3	2	-	-	-	-	3	2	-	1	2	0	-	-	-	-	2	0	-	-	-	-	-	-	-	-
	D	16	14	7	1	0	-	-	15	7	-	1	-	-	4	0	-	-	4	0	-	-	-	-	1	0	1	0
Tennessee	A	307	76	5	-	-	1	1	77	6	228	2	10	3	-	-	-	-	10	3	4	0	-	-	-	-	4	0
	B	15	7	3	-	-	1	1	8	4	7	-	2	0	-	-	-	-	2	0	1	1	-	-	1	0	2	1
	C	13	12	4	-	-	1	1	13	5	-	-	4	4	-	-	-	-	4	4	4	3	-	-	2	1	6	4
	D	17	13	5	-	-	-	-	13	5	4	-	3	3	1	1	-	-	4	4	6	4	2	1	-	-	8	5
Utah	A	20	19	12	-	-	-	-	19	12	1	-	1	1	-	-	-	-	1	1	-	-	-	-	1	0	1	0
	B	4	4	3	-	-	-	-	4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C	7	7	5	-	-	-	-	7	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	0	6	0
	D	7	7	3	-	-	-	-	7	3	-	-	-	-	-	-	-	-	-	-	-	-	1	0	5	1	6	1
Indiana	A	13	12	4	-	-	1	1	13	5	-	-	1	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-
	B	4	4	2	-	-	-	-	4	2	-	-	1	0	-	-	-	-	1	0	-	-	-	-	-	-	-	-
	C	2	2	2	-	-	-	-	2	2	-	-	1	1	-	-	-	-	1	1	-	-	1	1	-	-	1	1
	D	8	8	7	-	-	-	-	8	7	-	-	4	4	2	1	-	-	6	5	2	2	2	0	-	-	4	2
Colorado	A	103	79	38	-	-	-	-	79	38	9	15	1	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-
	B	17	17	13	-	-	-	-	17	13	-	-	-	-	1	0	-	-	1	0	1	1	-	-	-	-	1	1
	C	6	6	5	-	-	-	-	6	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	1	0
	D	4	4	2	-	-	-	-	4	2	-	-	1	0	-	-	-	-	1	0	-	-	1	0	-	-	1	0
Group I2/	A	26	15	4	-	-	-	-	15	4	10	1	5	4	-	-	-	-	5	4	1	1	-	-	-	-	1	1
	B	12	10	2	-	-	-	-	10	2	1	1	3	2	-	-	-	-	3	2	2	2	-	-	1	0	3	2
	C	9	8	2	-	-	-	-	8	2	1	-	2	0	-	-	-	-	2	0	-	-	-	-	1	0	1	0
	D	8	7	3	-	-	-	-	7	3	1	-	3	3	-	-	-	-	3	3	1	1	-	-	-	-	1	1
Group II3/	A	153	68	15	-	-	2	1	70	15	60	23	14	5	-	-	-	-	14	5	1	1	1	0	-	-	2	1
	B	20	10	4	-	-	-	-	10	4	2	8	3	2	-	-	-	-	3	2	-	-	-	-	-	-	-	-
	C	2	2	1	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		3,413	2,770	785	7	1	9	6	2,786	792	561	66	323	202	49	10	20	6	392	218	123	97	129	22	86	7	338	126
Percent with reported dust				28.3		14.3		66.7		28.4				62.5		20.4		30.0		55.6		78.9		17.1		8.1		37.3

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TABLE 6. - Use and relative effectiveness of dust-control measures during drilling in bituminous-coal and lignite mines. A: By States and mine class (Con.)

State	Mines		Draw-slate drilling																Bottom drilling													
			Rotary drilling								Percussion drilling								Rotary drilling								Percussion drilling					
			No controls		Dry with collector		Wet		Total		No controls		Dry with collector		Wet		Total		No controls		Dry with collector		Wet		Total		No controls		Dry with collector		Wet		Total	
	Class mines 1/	Number	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust
West Virginia (Northern)	A	171	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B	79	3	1	-	-	-	-	3	1	-	-	-	-	-	-	-	-	1	0	-	-	-	-	1	0	-	-	-	-	-	-
	C	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	27	2	2	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West Virginia (Southern)	A	39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-	-	-	-
	B	76	3	0	-	-	1	0	4	0	1	0	1	0	-	-	2	0	1	0	-	-	-	-	1	0	2	1	-	-	2	1
	C	61	2	2	-	-	1	0	3	2	2	1	2	0	-	-	4	1	-	-	-	-	-	-	-	-	3	2	2	0	6	2
	D	148	9	2	2	1	-	-	11	3	3	1	7	0	12	0	22	1	1	0	-	-	2	0	3	0	10	4	4	1	34	5
Pennsylvania	A	280	5	2	-	-	-	-	5	2	1	1	-	-	-	-	1	1	19	0	-	-	3	0	22	0	1	0	-	-	1	0
	B	103	4	1	-	-	-	-	4	1	1	1	-	-	-	-	1	1	16	6	-	-	-	-	16	6	3	2	-	-	3	2
	C	31	3	1	-	-	-	-	3	1	-	-	-	-	-	-	-	-	4	3	1	0	-	-	5	3	2	2	-	-	2	2
	D	95	9	5	12	5	4	0	25	10	4	3	2	0	1	0	7	3	7	2	1	0	-	-	8	2	10	5	9	3	25	10
Kentucky	A	416	5	1	-	-	-	-	5	1	-	-	-	-	-	-	-	-	16	9	-	-	-	-	16	9	1	1	-	-	1	1
	B	114	13	3	-	-	-	-	13	3	-	-	-	-	-	-	-	-	4	2	-	-	-	-	4	2	-	-	-	-	1	0
	C	49	5	4	1	0	-	-	6	4	2	2	1	0	-	-	3	2	4	2	-	-	-	-	4	2	2	0	-	-	-	-
	D	62	5	3	1	1	-	-	6	4	-	-	1	0	3	0	4	0	5	1	-	-	-	-	5	1	4	1	1	0	3	0
Illinois	A	15	2	1	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C	4	1	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	30	4	3	-	-	-	-	4	3	-	-	-	-	-	-	-	-	9	6	-	-	-	-	9	6	1	1	-	-	1	1
Virginia	A	298	-	-	-	-	-	-	-	-	1	1	-	-	-	-	1	1	2	0	-	-	-	-	2	0	1	0	-	-	1	0
	B	44	1	0	-	-	-	-	1	0	4	4	-	-	-	-	4	4	1	0	-	-	-	-	1	0	1	1	2	2	3	3
	C	12	1	1	-	-	-	-	1	1	1	1	1	0	-	-	2	1	1	1	-	-	-	-	1	1	1	1	1	0	2	1
	D	22	1	0	-	-	-	-	1	0	-	-	-	-	-	-	-	-	1	0	-	-	-	-	1	0	-	-	1	1	3	2
Alabama	A	178	1	0	-	-	-	-	1	0	1	0	-	-	-	-	1	0	12	1	-	-	1	0	13	1	4	1	-	-	5	1
	B	14	-	-	-	-	-	-	-	-	-	-	-	-	1	0	1	0	-	-	-	-	-	-	-	-	1	1	-	-	1	1
	C	8	2	0	-	-	-	-	2	0	-	-	-	-	-	-	0	0	1	0	-	-	-	-	1	0	-	-	-	-	-	-
	D	18	-	-	-	-	-	-	-	-	-	-	2	0	-	-	2	0	2	1	-	-	-	-	2	1	1	1	1	0	3	1
Ohio	A	166	1	0	-	-	-	-	1	0	-	-	-	-	-	-	-	-	3	1	-	-	-	-	3	1	-	-	-	-	-	-
	B	27	1	0	1	0	-	-	2	0	-	-	-	-	-	-	-	-	1	1	-	-	-	-	1	1	-	-	-	-	-	-
	C	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0	-	-	-	-	2	0	-	-	-	-	-	-
	D	16	7	5	1	0	-	-	8	5	-	-	-	-	-	-	-	-	1	0	-	-	-	-	1	0	-	-	-	-	-	-
Tennessee	A	307	2	0	-	-	-	-	2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C	13	1	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-	1	0
Utah	A	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	1	0
	B	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C	7	-	-	-	-	-	-	-	-	-	-	-	-	1	0	1	0	-	-	-	-	-	-	-	-	-	-	-	-	3	0	3	0
	D	7	-	-	-	-	-	-	-	-	-	-	-	-	4	0	4	0	-	-	-	-	-	-	-	-	-	-	-	-	4	0	4	0
Indiana	A	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	B	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	-	-	-	-	1	0	-	-	-	-	-	-	-	-
	C	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	1	0	-	-	5	4
Colorado	A	103	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-	-	3	1	1	1	-	-	-	-	1	1
	B	17	-	-	-	-	-	-	-	-	-	-	-	-	1	0	1	0	1	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-
	C	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-
Group I2/	A	26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-	2	1	-	-	-	-	-	-	-	-
	B	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	0	2	1
	C	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	3	0	4	1
	D	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	1	1	-	-	-	-	1	0	1	0
Group II3/	A	153	3	3	-	-	-	-	3	3	-	-	-	-	-	-	-	-	8	2	-	-	-	-	8	2	-	-	-	-	-	-	-	-
	B	20	1	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-	6	3	-	-	-	-	6	3	-	-	-	-	-	-	-	-
	C	2	1	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		3,413	98	44	18	7	6	0	122	51	21	15	17	0	23	0	61	15	137	46	2	0	6	0	145	46	56	31	22	7	48	3	126	41
Percent with reported dust			44.9		38.9		0.0		41.8		71.4		0.0		0.0		24.6		33.6		0.0		0.0		31.7		55.4		31.8		6.3		32.5	

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TABLE 6. - Use and relative effectiveness of dust-control measures during drilling in bituminous-coal and lignite mines. B: Breakdown of national totals by mine size

Location	Drilling method	Class A[1]			Class B[1]			Class C[1]			Class D[1]		
		Number	Visible dust	Percent	Number	Visible dust	Percent	Number	Visible dust	Percent	Number	Visible dust	Percent
Face drilling	Rotary, no control.....	1,660	401	24.2	460	135	29.3	211	85	40.3	439	164	37.4
	Rotary with control....	1	-	-	-	-	-	-	-	-	5	1	20.0
	Percussion, no control.	4	3	75.0	2	1	50.0	2	2	100.0	1	-	-
Roof drilling	Rotary, no control.....	139	81	58.3	68	35	51.5	37	24	64.9	79	62	78.5
	Rotary dry, dust collector.....	-	-	-	5	1	20.0	7	1	14.3	37	8	21.6
	Rotary wet.....	-	-	-	-	-	-	-	-	-	20	6	30.0
	Percussion, no controls	24	16	66.7	29	23	79.3	27	23	85.2	43	35	81.4
	Percussion dry, dust collector	1	-	-	9	2	22.2	16	3	18.8	103	17	16.5
	Percussion wet	1	-	-	5	-	-	17	1	5.9	63	6	9.5
Draw slate drilling	Rotary, no control	19	7	36.8	26	6	23.1	16	11	68.8	37	20	54.1
	Rotary dry, dust collector	-	-	-	1	-	-	1	-	-	16	7	43.8
	Rotary wet	-	-	-	1	-	-	1	-	-	4	-	-
	Percussion, no controls	3	2	66.7	6	5	83.3	5	4	80.0	7	4	57.1
	Percussion dry, dust collector	-	-	-	1	-	-	4	-	-	12	-	-
	Percussion wet	-	-	-	2	-	-	1	-	-	20	-	-
Bottom drilling	Rotary, no control	65	15	23.1	32	13	40.6	12	6	50.0	28	12	57.7
	Rotary dry, dust collector	-	-	-	-	-	-	1	-	-	1	-	-
	Rotary wet	4	-	-	-	-	-	-	-	-	2	-	-
	Percussion, no controls	8	3	37.5	8	6	75.0	9	6	66.7	31	16	51.6
	Percussion dry, dust collector	-	-	-	2	2	100.0	3	-	-	17	5	29.4
	Percussion wet	2	-	-	2	-	-	7	-	-	37	3	8.1

1/ Mine classes: A = 1-14 men underground, B = 15-49, C = 50-99, D = 100 or more.
2/ Group I consists of Wyoming, Oklahoma, Washington, and Arkansas, listed in order of production.
3/ Group II consists of Iowa, Montana, New Mexico, Missouri, and Maryland, listed in order of production.

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Only 7 of the 2,786 mines that drilled in the coal face with power drills were reported to use any form of dust-control measures. One of the seven was reported as producing visible dust while drilling. Nine mines drilled the coal face with percussion drills, and none used dust-control measures.

The 561 mines that drilled with hand augers were mostly small mines (Title I) employing less than 15 men.

Roof Drilling

Generally, more rotary than percussion drills were used for drilling roof rock, except in West Virginia where percussion drills were in the majority. The relative effectiveness of the control methods and their proportionate use is shown for roof drilling in figure 3(a) and (b). As stated before, water was not as effective for allaying the dust from rotary drills as it was for dust produced by percussion drills. This is evident from the data presented in table 6. The greatest use of dust collectors and wet drilling was in the class D (100 or more men) mines, and virtually no controls were used in the very small mines.

In spite of the hazard from dust produced by drilling roof, only 39 percent of the mines that drilled roof used any form of dust control. In nearly half the mines that drilled roof, visible dust was reported during drilling whether or not controls were used. Of the mines in which dust controls were used, 81 percent appeared by observation to be controlling the dust effectively.

Draw-Slate Drilling

Most draw-slate drilling was practiced in West Virginia, Pennsylvania, and Ohio, where the Pittsburgh coal bed is predominant, and in Kentucky, where the coal beds generally are low. In the Pittsburgh coal bed the draw slate generally is removed for safety reasons, while in Kentucky it is taken down for additional working height.

The use and relative effectiveness of the control measures used for draw-slate drilling are shown graphically in figure 4(a) and (b). It can be seen from these figures that the control methods do a better job on percussion drills than on rotary drills. By comparing the graphs for percussion and rotary drilling, it is evident also that more controls were used for percussion drills than for rotary drills, even though nearly twice as many rotary units were in use. Draw-slate generally is drilled with horizontal holes, and the cuttings produced fall only from the collar of the hole to the floor and are not thrown into suspension to the extent that results with vertical drilling. These horizontal holes usually are drilled with the same drills used for the coal face, which generally are slower than those intended for roof drilling. These factors tend to explain the fact that so many mines were observed in which draw slate was drilled without controls, yet without producing visible dust.

Bottom Drilling

Rotary drills were found in more general use than the percussion type for bottom drilling. The use and relative effectiveness of the two types of drills are shown graphically in figure 5(a) and (b). Water is a more effective dust control for downward drilling than for drilling in other directions, as the dust does not fall free from the hole and in that manner become suspended. Dust collectors were not as successful in controlling the dust from down holes as they were from others.

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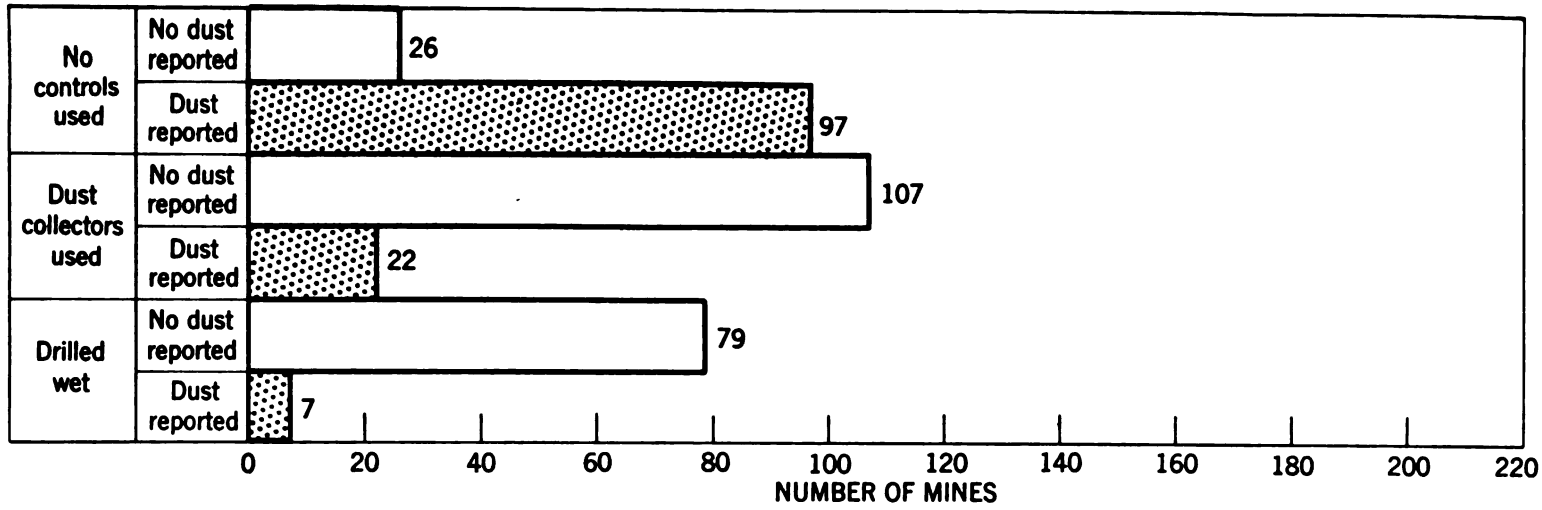
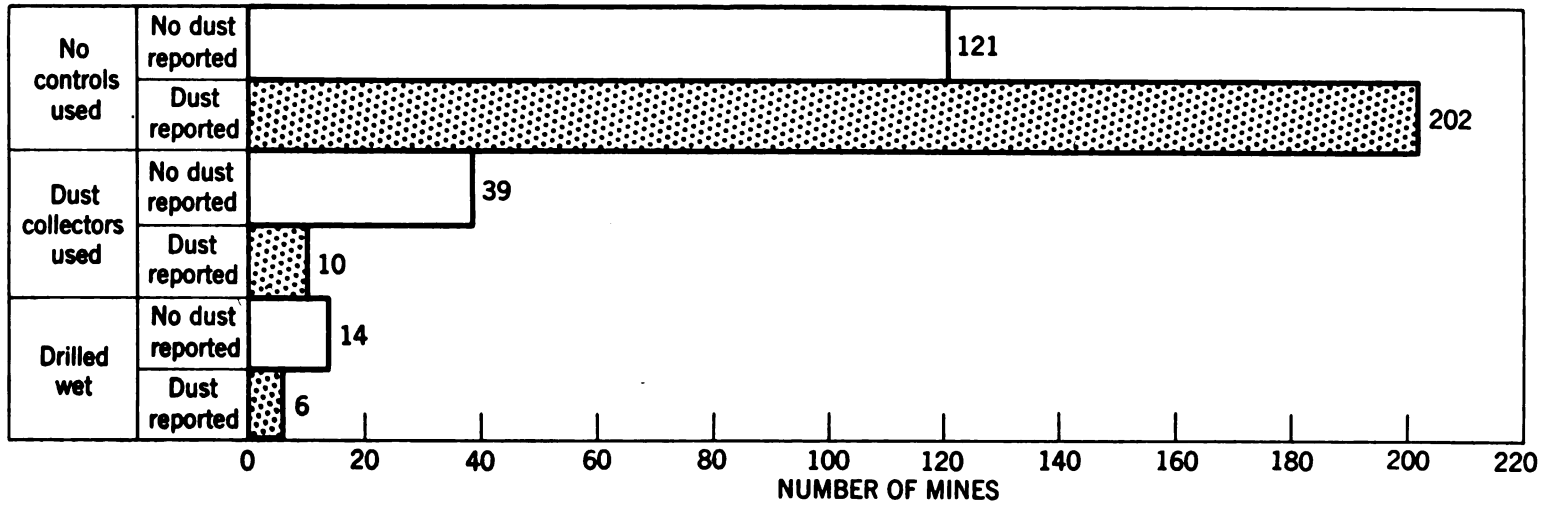


The use and relative effectiveness of dust controls used during percussion drilling in 338 mines.



The use and relative effectiveness of dust controls used during rotary drilling in 392 mines.

Figure 3. - Roof drilling.

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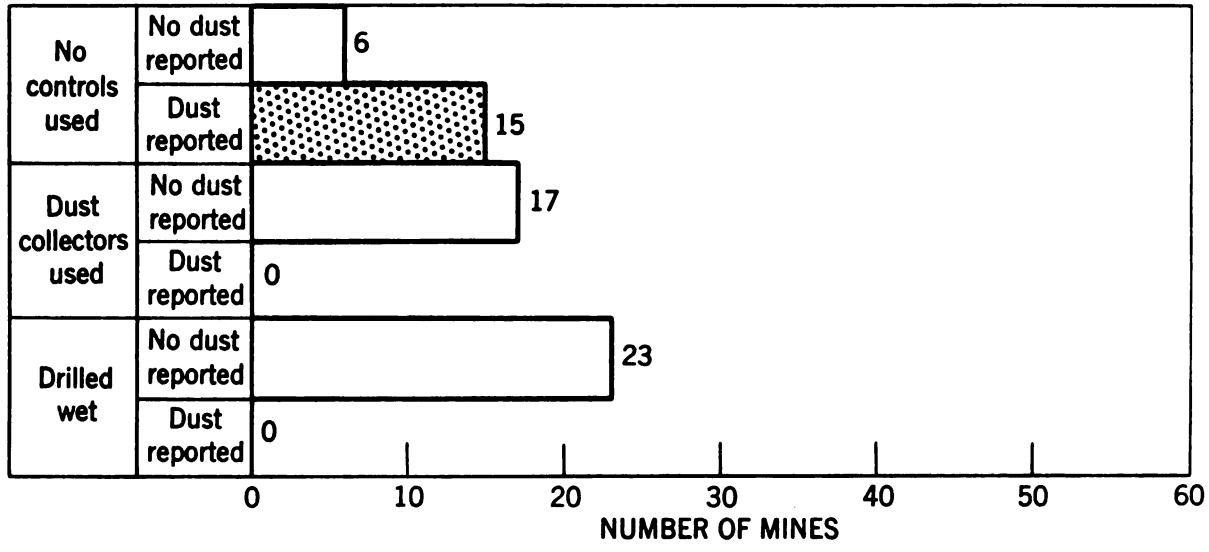
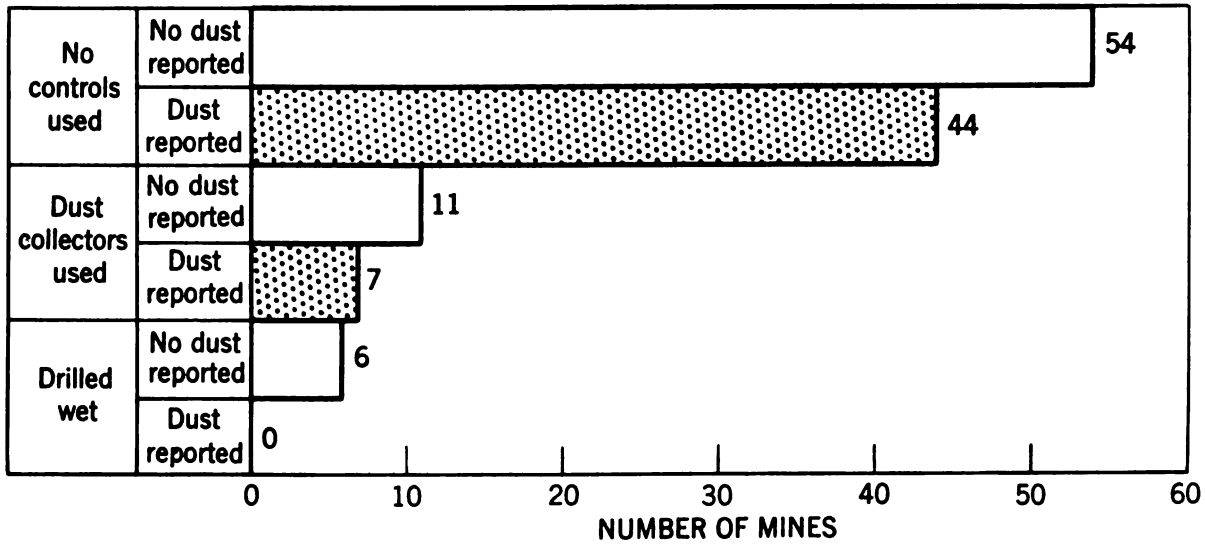


The use and relative effectiveness of dust controls used during percussion drilling in 61 mines.



The use and relative effectiveness of dust controls used during rotary drilling in 122 mines.

Figure 4. - Draw-slate drilling.

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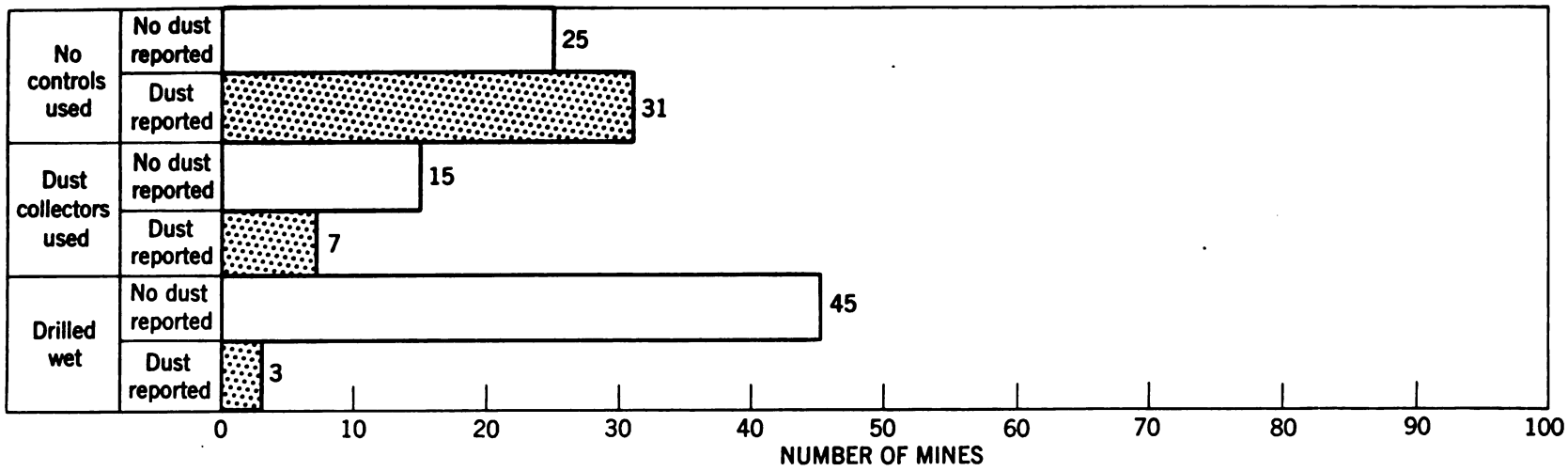
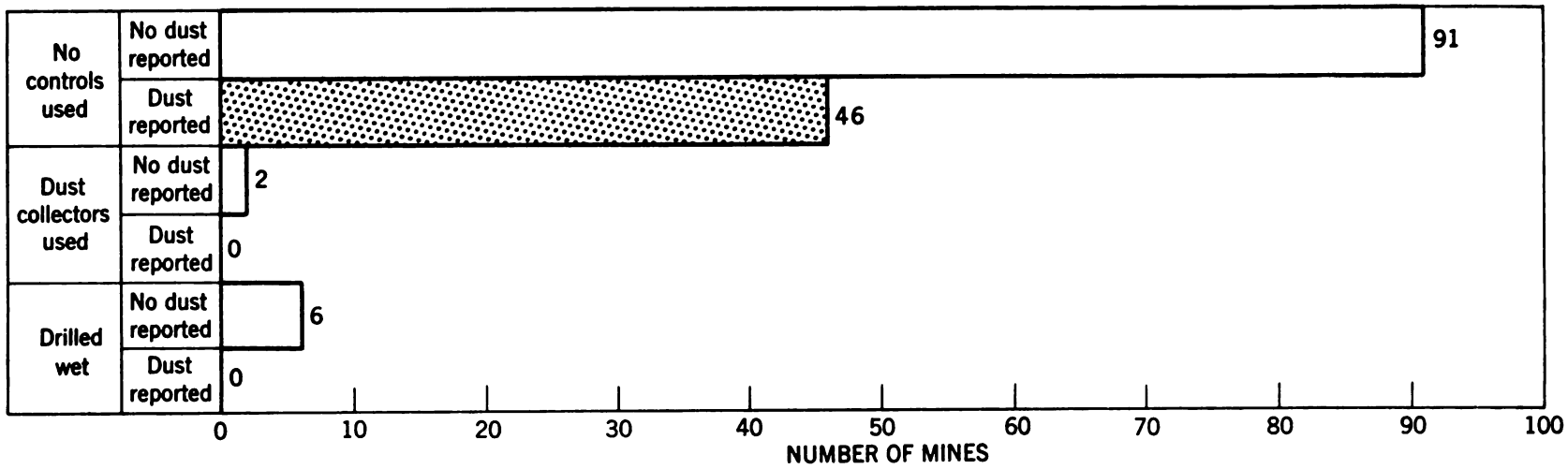


Use and relative effectiveness of dust controls used during percussion drilling in 126 mines.



Use and relative effectiveness of dust controls used during rotary drilling in 145 mines.

Figure 5. - Bottom drilling.

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A proper fit between the collector head and an uneven floor is difficult to obtain, and the use of high-pressure air through the drill steel to blow the cuttings from percussion drill holes makes it difficult for a dust collector to perform efficiently, although if reasonable care is exercised collectors can be made to operate as efficiently on bottom holes as in any other situation.

Bottom generally is drilled to take up bottom rock to give additional height in thin seams, and for the most part, is confined to southern West Virginia, Pennsylvania, and Kentucky. The majority of mines practicing bottom drilling in these States were in classes A, B, and C, and used no controls; those class D mines that did drill bottom employed most of the controls that were observed.

Coal Cutting

Sixty-two percent of the mines covered by this survey cut the coal by machine before blasting. The remaining 38 percent consisted of small mines that blasted off the solid, mines worked by hand, and a few larger mines where continuous mining machines were used exclusively. In the Middle West, a few mines were operated on a semilongwall face where roof pressure breaks down the coal.

For this survey, coal cutting was divided into Bottom cutting and Other than bottom cutting. The latter classification covers considerable variation in types of cutting. A breakdown of Other cutting is given in table 7.

TABLE 7. - Cutting practices in other than bottom in bituminous-coal and lignite mines

Type of cutting	Controls used			No controls used		
	Number of mines	Visible dust		Number of mines	Visible dust	
		Number	Percent		Number	Percent
Top	19	12	63.2	59	41	69.5
Bottom; shear	57	30	52.6	21	17	81.0
Top; shear	60	42	70.0	9	7	77.8
Bottom; top; shear	28	19	67.9	4	1	25.0
Center	2	1	50.0	14	9	64.3
Center; shear	6	0	0	1	1	100.0
Bottom; center	3	3	100.0	4	2	50.0
Shear	1	0	0	2	1	50.0
Total mines		176			114	
Number with visible dust		107			79	
Percent with visible dust		60.8			69.3	

It is recognized that coal cutting is an extremely dusty operation and that the dust clouds produced frequently are very dense, especially in dry coal beds. It is usually in the dry beds that attempts are made to allay the dust. In many instances the control measures used are not entirely effective; however, the dust concentration may be reduced considerably. It would be misleading to correlate the percentage of mines producing visible dust between mines using controls and those using none at all, because of the varying moisture content of the coal beds in different localities.

Figure 6 indicates the use and effectiveness of dust-control measures, and the distribution of mines that used or did not use controls.

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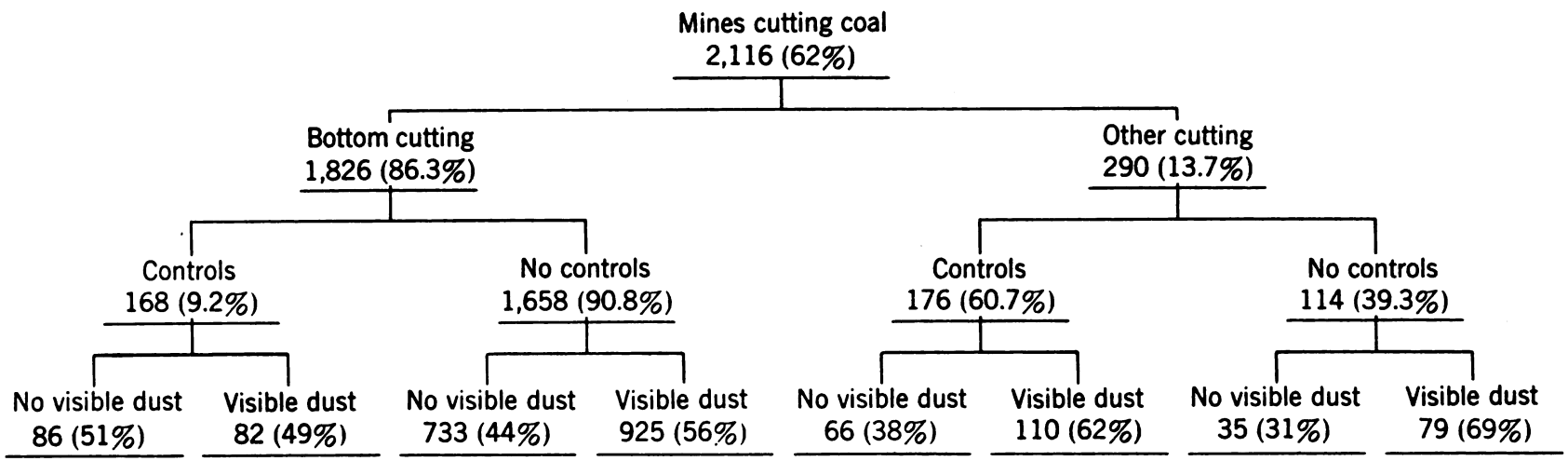

Figure 6. - Use and relative effectiveness of controls during cutting.

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Only 16 percent of the mines reported employed dust-control measures while cutting coal. Sixty-one percent used controls when cutting other than bottom, such as top cutting, center cutting, and shearing. Only nine percent of the mines used controls during bottom cutting. This, as well as a lower efficiency in the use of controls in other cutting is to be expected. Tests have demonstrated that, in general, the farther the cuttings have to fall, the denser is the concentration of airborne dust. However, height of coal alone is no criterion of low dust concentrations, for high dust counts have been recorded in low coal and also during bottom cutting. In this survey more than one-half the mines cutting bottom with no controls were observed as dusty.

Dust is controlled by applying water to the machine cuttings as they leave the cut or as they are produced. There are various methods of applying water: Sprays are installed on the cutting machine to wet the material as it leaves the cut or on the cutter bar to wet coal during the cutting operation, and in some mines, hand-held hoses are played on the cutter bar and the cuttings as they leave the kerf. In dry, dusty coal, however, the best of these methods is not usually totally effective. The ineffectiveness of dust-control measures stems largely from improper application of water or lack of understanding of the principles of dust control. Once dust has become airborne, it is almost impossible to wet it and remove it from the air. To control dust satisfactorily it must be wetted before or at the instant it becomes airborne. In general, this involves using a marrow-angle spray that will strike the dust particles as they emerge from the kerf - strike them with enough force to wet them and cause them to impinge against the coal face. The narrow-angle spray consolidates the water and if properly designed will give less opportunity for the dust particles to pass through the spray. It also causes an air current to be set up that aids in carrying the dust particles against the coal face, which has been wetted by the water spray, and will tend to make the particles adhere. A properly designed system will give better control of dust, generally, with less water than a makeshift system.

Some of the factors that influence airborne dust concentrations besides inherent moisture and varying degrees of dustiness in the coal beds are: The height from which the dust falls, the speed at which the cutter chain travels, bit sharpness, rock intrusions, running the cutter bar at excessive speeds while withdrawing or sumping the cutter bar, and the volume of air sweeping the face. The fact that a mine is considered to be naturally wet is no indication that dust-control measures are not needed during cutting, for high dust counts have been obtained when the cutter bar was covered by water as it undercut the coal.

The survey showed that most mines in the leading coal-producing States control dust while cutting coal; for example, in mines in West Virginia, Pennsylvania, and Illinois and in the mines employing more than 100 men in other States. Among the smaller coal-producing States, Utah does a commendable job; in fact, it leads all States in the percentage of mines using control measures during cutting. The survey also evidenced the lack of control measures in many mines cutting at the bottom of the bed and a need for closer supervision of those mines cutting in other than bottom. With adequate application of water, close supervision, and a thorough knowledge of the factors influencing dusty conditions, the dust problems during cutting can be minimized.

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TABLE 8. - Cutting practices in bituminous-coal and lignite mines, by States and mine classes, showing the use and relative effectiveness of dust-control measures

State	Mines		Bottom cutting				Other cutting				Shot off solid	Pick mines	All continuous miners
			Controls used		No controls used		Controls used		No controls used				
	Class 1/	Number	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust			
West Virginia (Northern)	A	171	-	-	35	10	1	1	7	1	125	3	-
	B	79	3	3	42	16	10	10	18	17	6	-	-
	C	18	-	-	11	9	5	5	-	-	2	-	-
	D	27	2	0	-	-	21	18	4	4	-	-	-
West Virginia (Southern)	A	39	1	1	12	8	-	-	-	-	25	1	-
	B	76	3	2	63	33	2	1	5	3	3	-	-
	C	61	3	3	49	23	5	3	4	3	-	-	-
	D	148	23	4	90	56	18	8	17	9	-	-	-
Pennsylvania	A	280	3	1	203	93	2	2	2	1	34	32	(2)
	B	103	1	0	81	40	4	2	5	3	3	5	(3)
	C	31	2	0	20	14	6	4	3	3	-	-	-
	D	95	13	3	31	22	39	19	8	8	-	-	4
Kentucky	A	416	1	0	134	82	-	-	5	3	275	1	-
	B	114	1	1	105	62	-	-	5	3	3	-	-
	C	49	4	1	37	31	2	0	5	4	-	1	-
	D	62	4	1	43	28	11	7	4	4	-	-	-
Illinois	A	15	1	0	11	7	1	0	2	1	-	-	-
	B	11	2	2	8	7	-	-	-	-	1	-	-
	C	4	1	1	2	2	1	1	-	-	-	-	-
	D	30	13	13	5	3	8	7	3	1	-	-	1
Virginia	A	298	1	1	100	34	-	-	2	1	190	-	(4)
	B	44	2	0	30	8	2	1	2	0	8	-	-
	C	12	-	-	9	6	-	-	1	1	2	-	-
	D	22	4	1	10	5	5	1	3	3	-	-	-
Alabama	A	178	2	0	77	47	-	-	-	-	98	1	-
	B	14	5	0	5	4	-	-	-	-	3	-	1
	C	8	1	1	5	4	-	-	-	-	2	-	-
	D	18	7	1	6	4	3	2	1	0	1	-	-
Ohio	A	166	2	1	153	95	-	-	-	-	8	2	1
	B	27	-	-	24	20	1	1	1	1	-	-	1
	C	4	1	1	2	1	-	-	-	-	-	-	1
	D	16	5	2	2	2	8	2	-	-	-	-	1
Tennessee	A	307	-	-	22	2	-	-	-	-	283	2	-
	B	15	-	-	11	5	-	-	-	-	4	-	-
	C	13	-	-	13	9	-	-	-	-	-	-	-
	D	17	2	2	14	7	-	-	-	-	1	-	-
Utah	A	20	12	7	6	3	1	0	-	-	1	-	-
	B	4	3	3	-	-	1	0	-	-	-	-	-
	C	7	2	2	-	-	5	4	-	-	-	-	-
	D	7	-	-	-	-	7	6	-	-	-	-	-
Indiana	A	13	-	-	10	8	-	-	-	-	3	-	-
	B	4	-	-	4	4	-	-	-	-	-	-	-
	C	2	-	-	1	1	-	-	1	1	-	-	-
	D	8	1	1	5	5	-	-	2	2	-	-	-
Colorado	A	103	8	5	61	50	-	-	-	-	16	18	-
	B	17	7	5	7	6	2	1	-	-	1	-	-
	C	6	5	4	1	1	-	-	-	-	-	-	-
	D	4	1	1	1	1	1	1	-	-	-	1	-
Group I	A	26	2	0	13	7	-	-	1	1	9	1	-
	B	12	4	2	-	-	2	1	-	-	5	-	1
	C	9	5	2	4	3	-	-	-	-	-	-	-
	D	8	4	4	1	1	2	2	-	-	1	-	-
Group II	A	153	-	-	62	25	-	-	2	1	85	4	-
	B	20	-	-	16	10	-	-	1	0	1	2	-
	C	2	1	0	1	1	-	-	-	-	-	-	-
	D	-	-	-	-	-	-	-	-	-	-	-	-
	Total	3,413	168	82	1,658	925	176	110	114	79	1,199	74	12
Dust, percent			48.8		55.8		62.5		69.3				5/12

National total — Breakdown by mine size

Cutting method	Class A			Class B			Class C			Class D		
	Number	Visible dust	Percent	Number	Visible dust	Percent	Number	Visible dust	Percent	Number	Visible dust	Percent
Bottom, controls used	33	16	48.5	31	18	58.1	25	15	60.0	79	33	41.8
Bottom, no controls used	899	471	52.4	396	215	54.3	155	105	67.7	208	134	64.4
Other cutting, controls used ..	5	3	60.0	24	17	70.8	24	17	70.8	123	73	59.3
Other cutting, no controls used	21	9	42.9	37	27	73.0	14	12	85.7	42	31	73.8

1/ Mine classes: A = 1-14 men underground, B = 15-49, C = 50-99, D = 100 or more. 2/ Class A mines used 1 auger-type machine, and 3 mines used pneumatic picks. 3/ Class B mines; 2 mines used auger-type machines, and 1 mine used pneumatic picks. 4/ Five class A mines used auger-type machines. 5/ 12 mines used other cutting methods.

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Blasting

Table 9 contains information on blasting procedure, explosives used to break down the coal face, personnel involved, and the extent of ventilation and wetting used to control dust and smoke during and after blasting.

For the greater part the coal face was shot by certified shot firers in the larger mines and by workmen in the smaller mines. Ninety-three percent of the shooting was done during the working shift; this percentage includes many of the small mines that blasted off the solid.

Some mines, especially the larger ones, wetted down the broken coal with a hose after blasting to prevent the dust from becoming airborne during loading. In Washington a few mines used a fog gun during and after the blasting operation that utilized compressed air and water to spray the coal with fine mist. This practice is reported to be effective in lowering the amount of airborne dust produced by blasting and loading.26/

Dust and smoke were visible when men returned to the face after blasting, especially in some smaller mines. This was because men returned too quickly, or there was not enough ventilation to carry away the smoke and dust. Inadequate ventilation was reported in those mines that used natural ventilation and in some mines that carried the ventilation only to the last crosscut.

Of the coal-breaking agents, permissible explosives were used in the greater proportion of the mines. Black blasting powder was confined to the smaller mines, and compressed air and carbon dioxide were used to a lesser extent in the larger mines. One mine was reported using a new chemical coal breaker.

Loading

Coal was loaded by hand in approximately three-fourths of the mines covered in this survey; however, these mines represented only a small proportion of the total coal production and the total number of men employed in the coal industry of the United States. Only 1 percent of the mines loading coal by hand used control measures. Many of the small mines were reported to be naturally damp or wet; this condition varied from State to State, and controls were not considered necessary in this case. Hand loading is not an extremely dusty operation; but in dry, dusty mines that lack proper ventilation, airborne dust may become extremely concentrated. Sprinkling coal before or during hand loading proved effective; only 1 out of the 25 hand-loading mines using this method of dust control was reported as having visible dust. In view of this effectiveness, more mines should attempt to wet coal before or during hand loading.

The bulk of the coal produced in the United States is loaded mechanically, and mechanical loading was used exclusively in 20 percent of the mines surveyed. Because of rougher handling, mechanical loading produces considerably more dust than hand loading. This is caused by the loading actions of the machines and the conveyors dumping the coal into shuttle cars or mine cars. Probably the dustiest operation is loading cuttings or "bug dust" produced during the cutting operation. Only 16 percent of the mines loading coal mechanically used control measures during loading. Controls consisted mainly of hand-held hoses, which wetted the coal before the loading machine entered the place to be loaded out, and/or sprays mounted on the loading machine, which wetted the coal during loading (see fig. 7). Another means of allaying dust practiced by some mines is to wet mine cars before they are loaded. The wet sides of the cars will trap considerable dust as the coal is discharged from the loader into the mine car.

26/ McGuire, L. H., How Fog Guns and Multiple Shooting Promote Dust and Fume Control: Coal Age, vol. 57, 1952, pp. 108-110.

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TABLE 9. - Blasting practices and types of explosives used in bituminous-coal and lignite mines, by States and mine classes

State	Class[1]	Number of mines	Blasting practice							Blasting agents									
			Shot by shot firers	Shot by miners	Shot on shift	Shot off shift	Wetted after blasting	Need ventilation	Visible dust and smoke[2]	Permissible explosives	Compair or Airdox	Cardox	Permissible and Airdox[3]	Permissible and Cardox[3]	Black powder or dynamite	Permissible with cap and fuse	Permissible and black powder[3]	No blasting	Chemical coal breakers
West Virginia (Northern)	A	171	10	158	168	-	-	11	39	167	-	1	-	-	-	-	-	3	-
	B	79	32	47	78	1	-	9	24	78	-	-	-	1	-	-	-	-	-
	C	18	9	9	18	-	-	4	6	18	-	-	-	-	-	-	-	-	-
	D	27	26	1	27	-	2	1	3	27	-	-	-	-	-	-	-	-	-
West Virginia (Southern)	A	39	13	26	37	2	-	-	3	39	-	-	-	-	-	-	-	-	-
	B	76	51	25	74	2	3	-	2	66	4	2	2	2	-	-	-	-	-
	C	61	48	13	61	-	4	-	9	47	8	2	3	1	-	-	-	-	-
	D	148	120	28	148	-	22	2	9	115	12	3	11	7	-	-	-	-	-
Pennsylvania	A	280	23	256	273	6	1	13	38	254	-	-	-	1	22	-	2	1	-
	B	103	25	76	99	2	1	1	2	100	-	-	-	1	-	-	-	2	-
	C	31	17	14	31	-	3	-	1	29	-	-	1	1	-	-	-	-	-
	D	95	84	10	91	3	25	1	13	81	4	-	4	5	-	-	-	1	-
Kentucky	A	416	245	169	413	1	-	31	75	400	1	-	-	-	4	9	-	2	-
	B	114	90	24	96	18	-	-	10	107	4	1	1	-	-	-	-	-	-
	C	49	44	4	48	-	1	2	4	42	2	-	1	3	-	-	-	1	-
	D	62	51	11	62	-	5	3	6	51	4	-	5	2	-	-	-	-	-
Illinois	A	15	13	2	2	13	-	-	1	6	2	-	-	-	6	-	1	-	-
	B	11	11	-	6	5	-	1	5	6	5	-	-	-	-	-	-	-	-
	C	4	4	-	3	1	1	-	1	-	3	-	1	-	-	-	-	-	-
	D	30	29	-	22	7	3	4	12	5	20	-	3	-	-	-	-	1	1
Virginia	A	298	203	95	292	6	-	5	13	244	-	-	-	-	17	37	-	-	-
	B	44	36	8	44	-	-	-	-	43	1	-	-	-	-	-	-	-	-
	C	12	9	3	12	-	-	-	-	10	1	-	1	-	-	-	-	-	-
	D	22	17	5	22	-	2	-	1	19	-	-	-	3	-	-	-	-	-
Alabama	A	178	29	148	158	19	-	21	3	126	-	-	-	-	48	-	3	1	-
	B	14	9	4	13	-	2	-	-	13	-	-	-	-	-	-	-	1	-
	C	8	6	2	7	1	1	-	-	8	-	-	-	-	-	-	-	-	-
	D	18	15	3	17	1	7	-	-	18	-	-	-	-	-	-	-	-	-
Ohio	A	166	10	155	159	6	-	22	22	33	-	-	-	-	132	-	-	1	-
	B	27	7	19	26	-	-	-	6	26	-	-	-	-	-	-	-	1	-
	C	4	2	2	4	-	-	-	-	4	-	-	-	-	-	-	-	-	-
	D	16	14	1	15	-	3	-	2	6	8	1	-	-	-	-	-	1	-
Tennessee	A	307	10	295	305	-	-	13	40	238	-	-	-	-	58	2	7	2	-
	B	15	8	7	13	2	-	-	1	15	-	-	-	-	-	-	-	-	-
	C	13	8	5	13	-	-	1	1	13	-	-	-	-	-	-	-	-	-
	D	17	8	9	17	-	-	-	-	17	-	-	-	-	-	-	-	-	-
Utah	A	20	19	1	5	15	12	2	2	20	-	-	-	-	-	-	-	-	-
	B	4	4	-	4	-	4	-	-	4	-	-	-	-	-	-	-	-	-
	C	7	7	-	7	-	7	-	1	5	-	-	2	-	-	-	-	-	-
	D	7	7	-	6	1	7	-	2	7	-	-	-	-	-	-	-	-	-
Indiana	A	13	11	2	13	-	-	-	-	6	-	-	-	-	7	-	-	-	-
	B	4	4	-	1	3	-	-	-	3	1	-	-	-	-	-	-	-	-
	C	2	2	-	2	-	-	-	-	-	2	-	-	-	-	-	-	-	-
	D	8	8	-	5	3	2	-	7	-	4	-	4	-	-	-	-	-	-
Colorado	A	103	88	-	66	22	3	1	4	79	-	3	-	6	-	-	-	15	-
	B	17	17	-	15	2	9	-	-	8	-	-	-	9	-	-	-	-	-
	C	6	6	-	6	-	5	-	-	2	2	-	-	2	-	-	-	-	-
	D	4	3	-	2	1	2	-	-	1	-	-	-	2	-	-	-	1	-
Group I	A	26	18	8	19	7	-	-	1	17	-	2	-	-	6	-	1	-	-
	B	12	11	1	9	3	4	-	-	11	-	1	-	-	-	-	-	-	-
	C	9	9	-	7	2	3	-	1	8	-	-	-	1	-	-	-	-	-
	D	8	7	1	7	1	7	-	-	8	-	-	-	-	-	-	-	-	-
Group II	A	153	76	68	77	67	2	-	-	86	-	3	1	-	54	-	-	9	-
	B	20	11	2	5	8	1	-	-	11	-	1	-	-	-	-	-	7	-
	C	2	2	-	2	-	1	-	-	-	1	-	1	-	-	-	-	-	-
	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Class totals	A	2,185	768	1,383	1,987	164	18	119	241	1,715	3	9	1	7	354	48	14	34	-
	B	540	316	213	483	46	24	11	50	491	15	5	3	13	-	-	-	11	-
	C	226	173	52	221	4	26	7	24	186	19	2	10	8	-	-	-	1	-
	D	462	389	69	441	17	87	11	55	355	52	4	27	19	-	-	-	4	1
Grand totals		3,413	1,646	1,717	3,132	231	155	148	370	2,747	89	20	41	47	354	48	14	50	1

1/ Mine classes: A = 1-14 men underground, B = 15-49, C = 50-99, D = 100 or more.
2/ Visible dust and smoke when men return to place.
3/ 2 blasting agents used at different points in the same mine.

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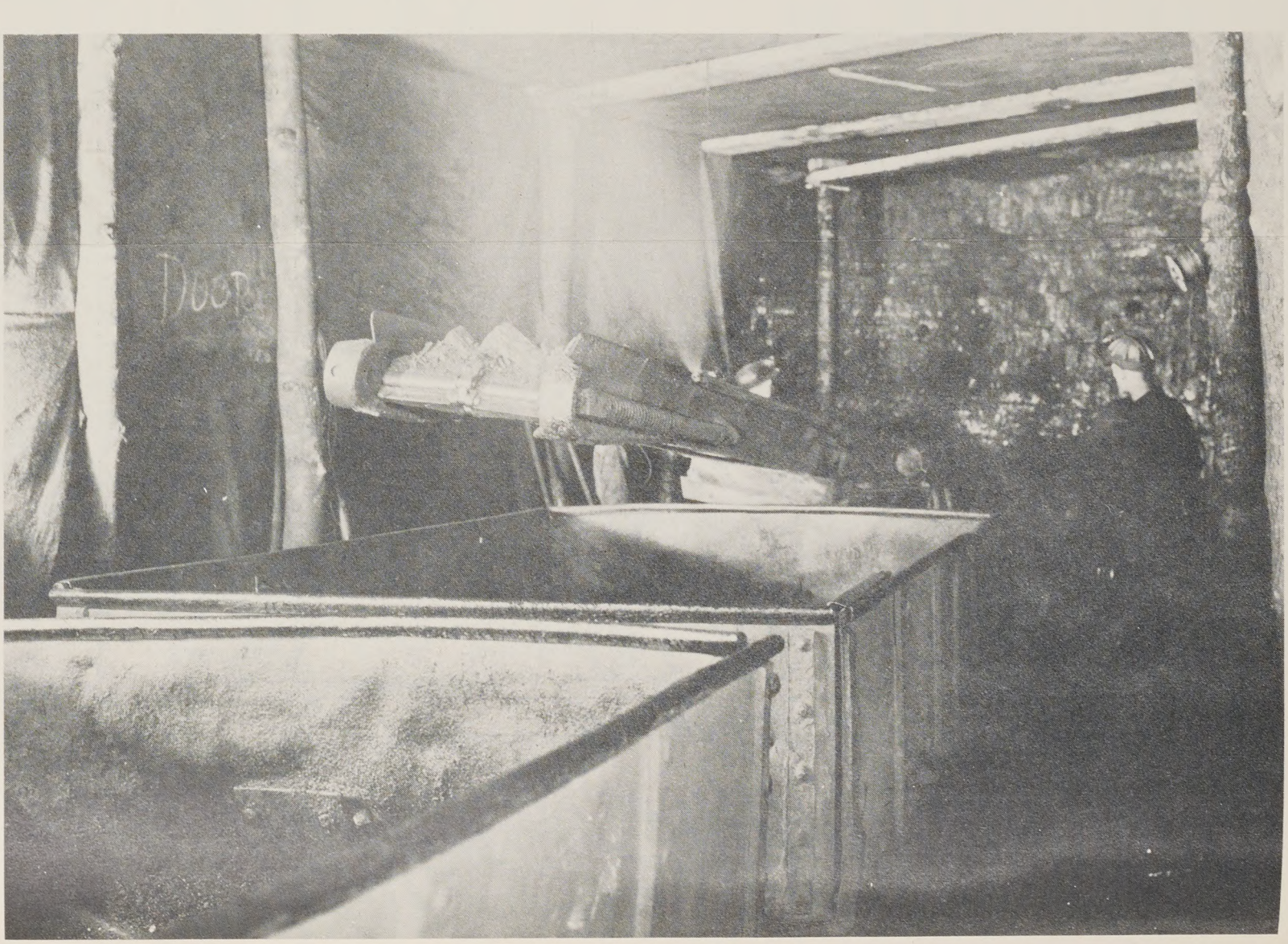

Figure 7. - Water sprays used to allay dust at discharge from loading machine.

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Although many mines were reported as not using controls before or during loading, the coal may have been wetted after blasting and may also have been wetted during cutting. This would tend to curb considerable dust during the loading of coal or machine cuttings.

Approximately 5 percent of the mines used both hand and mechanical means to load coal. The data on hand and mechanical loading are almost identical to those for mechanical loading in respect to use and effectiveness of control measures. With both methods 54-60 percent of the mines using no controls were reported to have visible dust, and control measures were reported to be 60-65 percent effective. The questionnaire did not yield information on the proportion of the coal in these mines that was loaded mechanically, but it probably made up the greater part of their tonnage.

A breakdown of the loading operation follows (fig. 8), showing the number of mines in each type of loading, those mines using or not using controls, and the relative effectiveness of the control measures used.

Continuous-Type Mining Machines

The advent of the continuous-type mining machine introduced an enhanced dust problem in the coal-mining industry, as it combines cutting, face drilling, blasting, and loading into one operation, thereby generally producing dense clouds of airborne dust. The coal produced by the machines is not as coarse as that produced by conventional mining machines, and the fine dust is more likely to become airborne. To maintain a continuous operation, the machines often are followed by a conventional loader or a shuttle car used as a surge bin. This results in more handling of the coal, more spillage on the bottom to be pulverized by moving equipment, and, consequently, increased dustiness.

To combat dusty conditions, the machines covered by this survey were equipped with an average of 4 sprays with water pressures varying from 100 to 400 p.s.i. Most sprays were mounted on the head; however, a few were reported to have been placed on each side of the boom. In addition to the sprays in most mines, a large volume of air was conducted to the face. A few of the mines used a wetting agent to help allay dust. One mine in Pennsylvania, in addition to sprays on the machine, placed sprays at the last crosscut on the return side of the line brattice.

Although all the continuous-type mining machines were equipped with sprays and most mines carried ventilation to the face, visible dust was observed in 76 percent of the mines in which the machines were used.

Transportation

During the underground handling and transportation of coal from the face regions to the dump or tipple, significant concentrations of airborne dust can be produced at a number of points. The point of transfer from one form of transportation to another was reported as the chief source of dust.

Generally, controls were not used at these transfer and discharge points, and dust clouds were visible in many instances. For example, only 20 percent of the mines used controls at shuttle-car discharge points, and over half of the controls appeared ineffective. Of the mines not using controls, nearly half were reported as having dusty conditions at shuttle-car discharge points.

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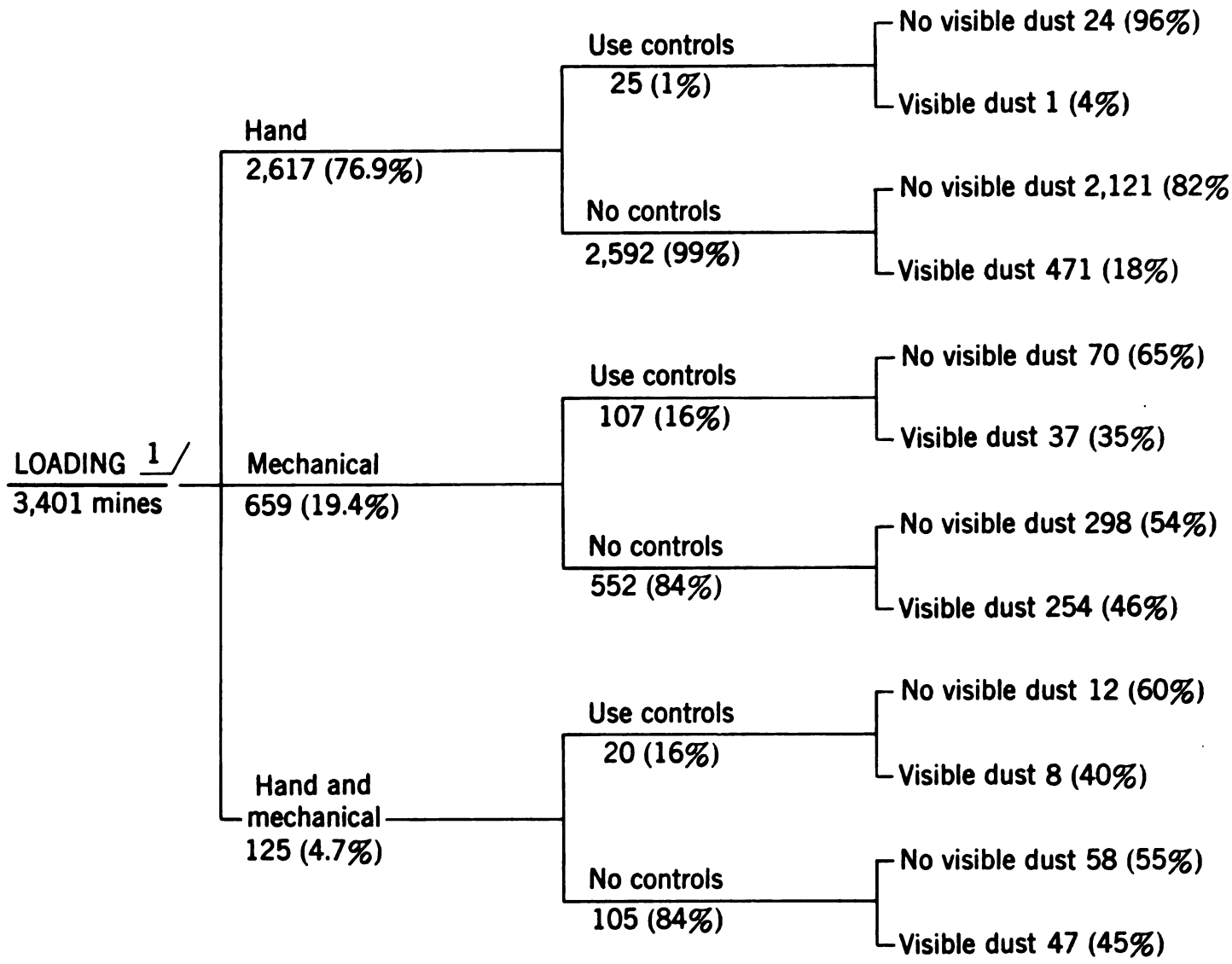

1/ Does not include 12 mines using continuous-type mining machines exclusively.

Figure 8. - A breakdown of loading practices, showing the use and relative effectiveness of control measures.

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TABLE 10. - Loading practices in bituminous-coal and lignite mines, by States and mine classes, showing the use and relative effectiveness of dust-control measures

State	Mines		Hand loading				Mechanical loading				Hand and mechanical loading				
			No controls		Controls		No controls		Controls		No controls		Controls		
	Class[1/]	Number	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust	Number	Visible dust	Continuous miners
West Virginia (Northern)	A	171	157	4	-	-	12	4	-	-	2	0	-	-	
	B	79	56	5	-	-	20	9	-	-	2	1	1	0	
	C	18	10	1	-	-	8	5	-	-	-	-	-	-	
	D	27	1	1	-	-	23	16	3	2	-	-	-	-	
West Virginia (Southern)	A	39	34	7	-	-	5	1	-	-	-	-	-	-	
	B	76	38	8	-	-	32	9	3	0	2	0	1	0	
	C	61	15	2	1	0	35	14	2	0	8	1	-	-	
	D	148	32	6	1	0	61	31	22	6	26	9	6	2	
Pennsylvania	A	280	259	32	2	0	15	4	1	0	3	3	-	-	
	B	103	81	11	-	-	16	2	1	0	4	1	-	-	1
	C	31	16	6	1	0	9	4	3	1	1	1	1	0	
	D	95	25	10	1	0	31	9	18	11	15	7	3	2	2
Kentucky	A	416	399	151	1	0	16	8	-	-	-	-	-	-	
	B	114	83	22	1	0	30	14	-	-	-	-	-	-	
	C	49	22	9	-	-	23	12	1	0	3	3	-	-	
	D	62	12	5	2	0	35	15	-	-	12	6	1	0	
Illinois	A	15	7	4	-	-	6	3	2	0	-	-	-	-	
	B	11	7	5	-	-	4	4	-	-	-	-	-	-	
	C	4	-	-	-	-	3	3	1	1	-	-	-	-	
	D	30	2	1	-	-	27	24	-	-	-	-	-	-	1
Virginia	A	298	293	7	3	0	2	0	-	-	-	-	-	-	
	B	44	35	1	-	-	8	0	-	-	1	0	-	-	
	C	12	3	1	-	-	7	2	-	-	2	0	-	-	
	D	22	5	1	-	-	10	3	-	-	6	2	1	1	
Alabama	A	178	176	26	-	-	2	0	-	-	-	-	-	-	
	B	14	8	4	-	-	3	1	2	0	-	-	-	-	1
	C	8	5	2	-	-	1	0	-	-	1	1	1	1	
	D	18	4	3	1	0	2	1	10	0	1	1	-	-	
Ohio	A	166	150	29	1	0	10	4	1	0	3	1	-	-	1
	B	27	20	3	1	0	4	3	-	-	1	1	-	-	1
	C	4	2	0	-	-	-	-	-	-	1	0	-	-	1
	D	16	-	-	-	-	11	2	3	0	1	1	-	-	1
Tennessee	A	307	306	14	-	-	1	1	-	-	-	-	-	-	
	B	15	13	2	-	-	2	0	-	-	-	-	-	-	
	C	13	4	0	-	-	4	2	-	-	5	5	-	-	
	D	17	9	2	-	-	7	4	-	-	1	0	-	-	
Utah	A	20	6	4	-	-	7	5	7	3	-	-	-	-	
	B	4	-	-	-	-	1	1	3	3	-	-	-	-	
	C	7	-	-	-	-	-	-	7	4	-	-	-	-	
	D	7	-	-	-	-	1	1	6	4	-	-	-	-	
Indiana	A	13	8	2	-	-	5	4	-	-	-	-	-	-	
	B	4	2	2	-	-	2	2	-	-	-	-	-	-	
	C	2	-	-	-	-	2	2	-	-	-	-	-	-	
	D	8	-	-	-	-	6	6	2	0	-	-	-	-	
Colorado	A	103	87	45	4	1	12	7	-	-	-	-	-	-	
	B	17	6	4	1	0	5	3	2	0	1	1	2	1	
	C	6	2	2	-	-	3	1	-	-	1	1	-	-	
	D	4	2	1	-	-	1	1	-	-	-	-	1	0	
Group I	A	26	19	6	-	-	6	2	1	0	-	-	-	-	
	B	12	5	3	-	-	4	1	1	0	-	-	-	-	2
	C	9	4	2	2	0	-	-	2	1	1	0	-	-	
	D	8	1	0	2	0	-	-	2	1	-	-	2	1	1
Group II	A	153	144	11	-	-	9	3	-	-	-	-	-	-	
	B	20	17	4	-	-	1	0	1	0	1	1	-	-	
	C	2	-	-	-	-	2	1	-	-	-	-	-	-	
	D	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Total	3,413	2,592	471	25	1	552	254	107	37	105	47	20	8	12

National totals		Class A[1/]			Class B[1/]			Class C[1/]			Class D[1/]		
		Number	Visible dust	Dust, percent	Number	Visible dust	Dust, percent	Number	Visible dust	Dust, percent	Number	Visible dust	Dust, percent
Hand loading	No controls	2,045	342	16.7	371	74	19.9	83	25	30.1	93	30	32.3
	Controls	11	1	9.1	3	0	0	4	0	0	7	0	0
Mechanical loading	No controls	108	46	42.6	132	49	37.1	97	46	47.4	215	113	52.6
	Controls	12	3	25.0	13	3	23.1	16	7	43.8	66	24	36.4
Hand and mechanical loading	No controls	8	4	50.0	12	5	41.7	23	12	52.2	62	26	41.9
	Controls	-	-	-	4	1	25.0	2	1	50.0	14	6	42.9

1/ Mine classes: A = 1-14 men underground, B = 15-49, C = 50-99, D = 100 or more.

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TABLE 11. - Use of continuous-type mining machines in bituminous-coal and lignite mines, by States and mine classes, showing methods used to allay airborne dust

State	Class 1/	Mines using continuous miners	Methods of dust control			
			Brattice to face	Auxiliary fans	Wetting	Visible dust
West Virginia (Northern)	B	1	-	-	1	1
	D	5	2	-	5	4
West Virginia (Southern)	B	1	-	-	1	0
	D	8	5	-	8	6
Pennsylvania	B	2	1	-	2	0
	C	2	2	-	2	2
	D	33	24	-	33	25
Kentucky	B	1	-	-	1	1
	C	2	-	2	2	2
	D	3	-	-	3	3
Illinois	D	4	1	-	4	4
Virginia	C	1	1	-	1	0
Alabama	B	1	1	-	1	1
	D	3	2	-	3	1
Ohio	A	1	1	-	1	1
	B	1	1	-	1	1
	C	1	-	-	1	1
	D	3	1	-	3	1
Utah	D	1	1	-	1	1
Indiana	D	1	-	-	1	0
Colorado	B	1	-	1	1	1
	C	2	-	1	2	2
Wyoming	D	1	1	1	1	1
Washington	B	2	2	-	2	2
	D	1	1	-	1	1
National class total	A	1	1	-	1	1
	B	10	5	1	10	7
	C	8	3	3	8	7
	D	63	38	1	63	47
Grand total		82	47	5	82	62

1/ Mine classes: A = 1-14 men underground, B = 15-49, C = 50-99, D = 100 or more.

Some dust was reported as visible during transportation. In a few mines the coal in cars or on conveyors was wetted during transportation (fig. 9). Dust was

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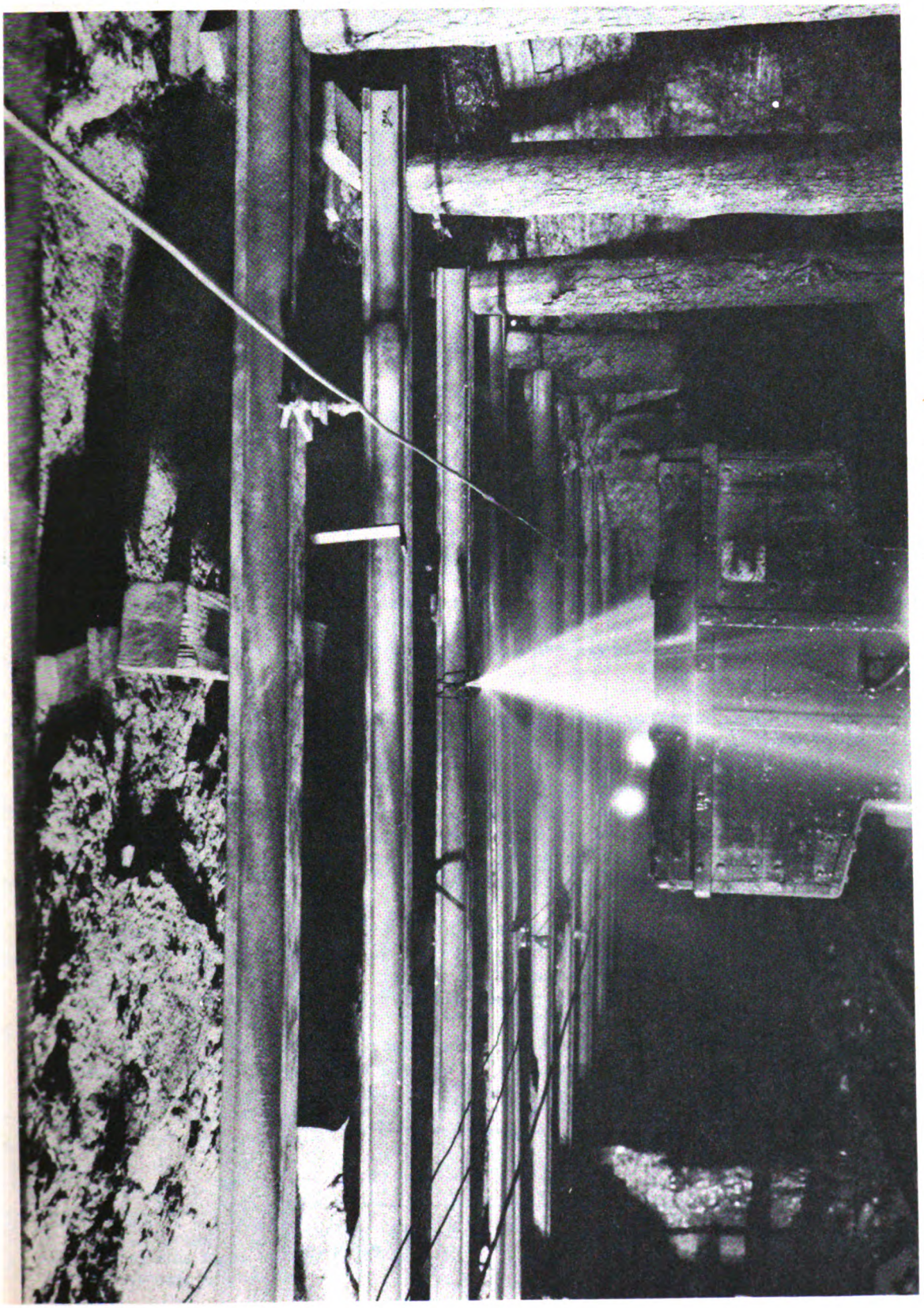

Figure 9. - Spraying water on loaded mine car before leaving the side track.

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reported in some cases on the mine-car haulageways, but the questionnaire did not reveal whether the source of the dust was the roadbed, traction sand, or the mine cars, which may have been overloaded or not tight; 2.4 percent of the mines wetted the coal during transportation, 25 percent of the mines used tight cars, and 10 percent of the mines overloaded the mine cars.

Nearly all mines employing more than 14 men cleaned up the loose coal on haulageways, and only 10 percent of the class A mines did not. Water and chemicals, such as salt and calcium chloride, were used on very few track haulageways, and such use was mostly in large mines. Chemicals were used on the main haulage in a considerable number of small mines in Virginia, but these mines used rubber-tired mine cars to transport the coal from the tipple to an outside dumping point. The shuttle-car runways were wetted or treated with chemicals to allay dust and consolidate the runway in the larger mines.

Tipples and Cleaning Plants

Other significant sources of airborne dust in the coal industry are the preparation and handling of coal after it leaves the mine. The installations covered in this survey ranged from simple mine car-to-truck dumps to large elaborate cleaning plants. In all instances the preparation pattern is much the same; and wherever coal is dumped, screened, crushed, or transported dust is produced, and dry coal will greatly enhance the dust concentrations produced by these operations.

Some plants have no dust problem, as their coal comes from the mine damp enough to prevent much dust from becoming airborne. Others have a tremendous problem. Crushing and screening operations were reported as the most common producers of visible airborne dust; however, conveyor discharge points, chutes, air cleaners, loading booms, and various other means of handling the coal also produced visible dust clouds.

Many plants used some form of control at one or more locations but also needed controls at other points. In tabulating the data the mines have been divided as to the use of controls and their relative effectiveness as determined by observation. The most widely used form of dust control was a water spray to wet the coal. Vacuum collectors, exhaust fans and hoods, and steam jets also were used. In the few instances in which it was used steam was reported as being very effective. In a few preparation plants water for spraying had a wetting agent added to it, and these sprays were reported to be quite effective.

Settled dust was cleaned by broom and shovel in most plants; however, many mines also washed down the plants with hoses when weather permitted, and a few of the modern preparation plants used vacuum cleaners. Virtually all mines kept the floors and ledges of the preparation plants relatively free from settled dust.

In general, a need was indicated for more control measures in tipples and preparation plants and closer supervision to obtain maximum effectiveness from these control measures.

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TABLE 12. - Use and relative effectiveness of dust-control measures during transportation in bituminous-coal and lignite mines, by States and mine classes; also the extent of application of water and chemicals to haulageways

	Mine cars								Shuttle cars							Conveyors							Haulageways			
	Mines		Wetted during transport	Cars overloaded	Cars tight	Dust visible		No cars	Mines using shuttle cars		Cars overloaded	Shuttle car discharge				Mines using conveyors		Wetted during transport	Conveyors overloaded	Transfer or dumping points				Wetted		Chemicals	
												Controls used		No controls						Controls used		No controls		Main haulage	Shuttle car haulage	Main haulage	Shuttle car haulage
State	Class 1/	Number				Haulageways	Narrow airways		Number	Percent		No dust	Visible dust	No dust	Visible dust	Number	Percent			No dust	Visible dust	No dust	Visible dust				
West Virginia (Northern)	A	171	-	3	2	1	-	3	2	1.2	-	-	-	1	1	2	1.2	-	-	-	-	2	-	-	1	-	-
	B	79	1	5	8	-	-	15	13	16.5	-	1	-	10	2	14	17.7	1	1	1	2	8	3	-	1	-	1
	C	18	-	2	1	-	-	2	5	27.8	-	1	-	2	2	3	16.7	-	-	1	1	-	1	-	-	-	-
	D	27	4	2	7	4	-	-	17	63.0	-	1	8	3	5	3	11.1	-	-	-	1	1	1	4	7	1	1
West Virginia (Southern)	A	39	-	-	13	1	-	5	4	10.3	1	-	-	4	-	5	12.8	-	1	-	1	2	2	-	-	-	-
	B	76	1	6	28	2	-	17	15	19.7	-	-	-	12	3	25	32.9	2	-	3	-	16	6	-	1	-	2
	C	61	4	11	25	3	-	11	28	45.9	3	2	3	14	9	21	34.4	3	2	4	4	7	6	-	2	1	5
	D	148	14	15	76	9	-	13	66	44.6	9	12	9	36	9	65	44.0	8	2	15	18	26	6	9	9	4	13
Pennsylvania	A	280	2	9	38	4	-	3	4	1.4	1	-	-	2	2	27	9.6	1	-	-	1	18	8	2	-	1	-
	B	103	1	15	13	3	4	3	9	8.7	6	3	-	4	2	22	21.4	1	-	2	1	15	4	-	2	-	2
	C	31	1	2	6	1	-	2	10	32.3	-	2	2	6	-	17	54.8	1	-	4	1	7	5	-	2	-	2
	D	95	17	19	48	12	3	2	55	57.9	-	7	9	28	11	31	32.6	5	-	3	12	9	7	6	18	3	13
Kentucky	A	416	-	119	29	60	-	18	19	4.6	4	-	1	14	4	10	2.4	-	-	-	1	5	4	-	-	-	-
	B	114	1	24	13	2	1	8	17	14.9	3	-	3	9	5	23	20.2	-	-	-	3	10	10	-	-	-	2
	C	49	1	12	5	5	1	4	19	38.8	2	-	4	8	7	13	26.5	1	-	1	4	5	3	1	2	-	4
	D	62	4	9	21	9	4	6	30	48.4	-	3	2	18	7	32	50.0	5	-	10	8	10	4	6	3	2	12
Illinois	A	15	-	-	5	-	-	1	5	33.3	-	-	-	2	3	-	-	-	-	-	-	-	-	1	-	1	2
	B	11	-	-	3	1	-	1	3	27.3	-	-	-	1	2	2	18.2	-	-	-	2	-	-	3	-	-	1
	C	4	1	1	1	1	-	-	4	100.0	-	-	1	1	2	-	-	-	-	-	-	-	-	1	-	-	3
	D	30	-	1	5	4	-	8	24	80.0	3	-	3	8	13	12	40.0	1	-	3	3	2	4	6	-	1	18
Virginia	A	299	-	16	152	22	-	2/22	20	6.7	2	-	-	18	2	8	2.7	-	-	-	-	7	1	-	-	3/19	2
	B	44	-	5	15	2	-	4	6	13.6	-	-	-	5	1	5	11.4	-	-	-	-	5	-	-	-	1	2
	C	12	-	-	6	2	-	-	4	33.3	-	1	-	2	1	4	33.3	-	-	-	-	2	2	1	1	-	1
	D	22	1	1	7	1	-	-	14	63.6	-	-	-	12	2	7	31.8	-	-	1	1	4	1	-	-	-	5
Alabama	A	178	-	4	64	2	-	2	-	-	-	-	-	-	-	22	12.4	1	-	1	1	12	8	1	-	-	-
	B	14	-	1	4	2	-	1	3	21.4	-	1	-	2	-	3	21.4	-	-	-	-	2	1	-	1	-	-
	C	8	-	-	3	1	-	-	1	12.5	-	-	-	1	-	3	37.5	-	-	1	1	1	-	-	-	-	-
	D	18	4	2	14	1	-	-	9	50.0	-	3	3	3	-	4	22.2	-	-	2	1	1	-	3	1	-	-
Ohio	A	166	-	18	30	1	-	2	3	1.8	-	-	-	3	-	11	6.6	-	-	1	-	8	2	-	-	-	-
	B	27	-	-	12	-	-	1	-	-	-	-	-	-	-	5	18.5	-	-	-	-	3	2	-	-	-	-
	C	4	-	-	-	-	-	-	1	25.0	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
	D	16	3	-	8	-	-	1	10	62.5	-	1	1	7	1	5	31.3	3	-	4	-	1	-	-	-	-	-
Tennessee	A	307	-	10	24	5	-	2	1	0.3	-	-	-	-	1	4	1.3	-	-	-	-	4	-	-	-	-	-
	B	15	-	1	-	3	-	-	-	-	-	-	-	-	-	3	20.0	-	-	-	-	1	2	-	-	-	-
	C	13	-	2	1	1	-	1	6	46.2	-	-	-	5	1	4	30.8	-	-	-	-	3	1	-	-	-	-
	D	17	1	4	1	2	-	-	4	23.5	1	-	2	-	2	7	41.2	-	1	2	1	-	4	-	1	-	-
Utah	A	20	2	2	3	2	-	9	9	45.0	-	-	2	6	1	6	30.0	-	-	-	2	-	4	6	1	1	-
	B	4	1	-	1	-	-	2	3	75.0	-	1	-	1	1	2	50.0	-	-	-	-	-	2	1	-	1	-
	C	7	2	-	2	1	-	-	6	85.7	-	1	-	4	1	2	28.6	-	-	-	-	1	1	2	-	-	-
	D	7	3	1	5	1	-	-	7	100.0	-	-	-	7	-	2	28.6	-	-	-	-	2	-	1	2	-	-
Indiana	A	13	-	-	7	3	-	-	1	7.7	-	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-	-
	B	4	-	-	2	-	-	1	2	50.0	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	2
	C	2	-	-	1	-	-	-	2	100.0	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2
	D	8	-	1	7	3	-	-	7	87.5	1	2	-	2	3	1	12.5	-	-	-	-	-	1	4	1	-	4
Colorado	A	103	-	-	30	3	-	1	4	3.9	-	-	-	3	1	28	27.2	-	-	-	-	17	11	-	-	-	-
	B	17	-	-	1	2	-	1	4	23.5	-	-	-	3	1	8	47.1	-	-	-	1	3	4	3	1	-	-
	C	6	-	-	3	-	-	1	3	50.0	-	-	-	-	3	5	83.3	-	-	-	-	1	4	-	1	-	-
	D	4	3	-	2	-	-	-	2	50.0	-	-	-	2	-	2	50.0	1	-	1	-	1	-	2	2	-	-
Group I	A	26	-	1	5	-	-	-	-	-	-	-	-	-	-	3	11.5	-	-	-	-	1	2	-	-	-	-
	B	12	-	1	1	-	-	1	1	8.3	-	-	-	1	-	5	41.7	-	-	-	2	2	1	1	-	-	-
	C	9	1	-	5	1	-	-	2	22.2	-	-	1	1	-	5	55.6	1	-	1	1	2	1	1	-	-	-
	D	8	2	-	5	2	-	-	2	25.0	-	-	-	1	1	4	50.0	1	-	-	-	3	1	2	-	-	-
Group II	A	153	2	1	33	1	-	2	1	0.7	-	-	-	1	-	6	3.9	-	-	-	-	6	-	16	1	-	-
	B	20	-	-	6	-	-	-	1	5.0	-	-	-	1	-	1	5.0	-	-	-	-	1	-	6	1	-	-
	C	2	1	-	2	-	-	-	1	50.0	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-
	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		3,413	78	326	809	186	13	176	489	14.3	36	43	55	276	115	502	14.7	36	7	61	74	237	130	92	62	36	99
Percent			4/2.4	4/10.1	4/25.0	4/5.7	4/0.4	5/5.2			6/7.3	8.8	11.2	56.5	23.5			7/7.2	1.4	12.2	14.7	47.2	25.9				
National totals by class	A	2,185	6	183	435	105	0	70	73	3.3	8	-	3	54	16	132	6.1	2	1	2	6	82	42	28	3	22	4
	B	540	5	58	107	17	5	55	77	14.3	9	6	4	49	18	118	21.9	4	1	6	11	66	35	14	7	2	12
	C	226	11	30	61	16	1	21	92	40.7	5	8	11	46	27	77	34.1	6	2	12	12	29	24	7	8	1	17
	D	462	56	55	206	48	7	30	247	53.5	14	29	37	127	54	175	37.7	24	3	41	45	60	29	43	44	11	66

1/ Mine classes: A = 1-14 men underground, B = 15-49, C = 50-99, D = 100 or more.
2/ In Virginia 49 Class A mines and 5 Class B mines used rubber-tired mine cars.
3/ Rubber-tired mine cars.
4/ These percentages are of those mines using mine cars (3,237).
5/ These percentages are of all mines (3,413).
6/ These percentages are of those mines using shuttle cars (489).
7/ These percentages are of those mines using conveyors (502).

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TABLE 13. - Dust-control practices in tipples and cleaning plants of bituminous-coal and lignite mines, by States and mine classes

State	Class[1/]	Number of mines	Tipple and cleaning plant Outside controls: Controls used effectively	Controls used ineffectively	Controls effective, but others needed	No controls and visible dust	No controls, dust at dumping point	No controls used or needed	No tipple, central plant
West Virginia (Northern)	A	171	-	-	-	3	4	163	1
	B	79	-	3	1	13	6	51	5
	C	18	-	1	1	7	1	6	2
	D	27	5	6	6	9	-	-	1
West Virginia (Southern)	A	39	-	1	-	2	5	28	3
	B	76	3	2	2	8	6	35	20
	C	61	6	4	4	17	1	15	14
	D	148	30	19	13	44	7	23	12
Pennsylvania	A	280	-	1	-	5	36	237	1
	B	103	-	2	-	15	13	68	5
	C	31	3	-	-	11	4	12	1
	D	95	34	5	12	26	-	14	4
Kentucky	A	416	-	1	-	5	141	264	5
	B	114	2	-	2	27	24	51	8
	C	49	1	2	3	24	6	8	5
	D	62	7	6	5	29	1	6	8
Illinois	A	15	-	-	-	2	6	7	-
	B	11	-	-	-	8	1	2	-
	C	4	-	-	-	4	-	-	-
	D	30	5	5	11	9	-	-	-
Virginia	A	298	-	-	-	2	12	284	-
	B	44	-	-	1	5	4	31	3
	C	12	2	-	1	4	-	4	1
	D	22	6	3	1	6	-	2	4
Alabama	A	178	2	1	-	3	12	158	2
	B	14	2	-	-	1	-	8	3
	C	8	-	-	-	1	1	6	-
	D	18	14	-	-	-	1	3	-
Ohio	A	166	-	-	-	10	38	118	-
	B	27	-	1	-	4	12	10	-
	C	4	-	-	-	2	2	-	-
	D	16	8	-	1	6	-	1	-
Tennessee	A	307	-	-	-	1	6	300	-
	B	15	-	-	-	3	1	11	-
	C	13	-	1	-	8	-	4	-
	D	17	3	1	-	10	1	2	-
Utah	A	20	-	-	-	12	5	3	-
	B	4	-	-	-	4	-	-	-
	C	7	1	1	2	3	-	-	-
	D	7	1	-	1	4	-	-	1
Indiana	A	13	-	-	-	1	8	4	-
	B	4	-	-	1	1	1	1	-
	C	2	-	1	-	-	-	1	-
	D	8	1	-	2	4	-	1	-
Colorado	A	103	-	-	-	8	51	44	-
	B	17	-	-	-	6	10	1	-
	C	6	-	-	-	5	1	-	-
	D	4	-	2	-	1	-	1	-
Group I	A	26	-	-	-	5	5	16	-
	B	12	1	-	1	5	-	3	2
	C	9	-	1	-	6	1	1	-
	D	8	1	-	-	4	1	2	-
Group II	A	153	-	-	-	6	29	118	-
	B	20	-	-	-	5	3	12	-
	C	2	-	1	-	1	-	-	-
	D	-	-	-	-	-	-	-	-
Class total	A	2,185	2	4	0	65	358	1,744	12
	B	540	8	8	8	105	81	284	46
	C	226	13	12	11	93	17	57	23
	D	462	115	47	52	152	11	55	30
Totals		3,413	138	71	71	415	467	2,140	111

1/ Mine classes: A = 1-14 men underground, B = 15-49, C = 50-99, D = 100 or more.

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Discussion of Auxiliary Operations

Ventilation

In relation to dust control, ventilation sweeps dust away from the point where it is produced and thus aids the workmen in that place. Where several operations are being performed on the same split of air, however, this dust may be carried into other places where men are working and expose them to an additional dust hazard. Ventilation has no tendency to allay dust produced during the various mining operations, except to impinge small quantities of airborne dust on damp surfaces contacted by the air currents and to dilute the concentration.

Ventilation practices of the different coal-producing States did not vary greatly, as the national totals for the industry show in table 14. A State-by-State breakdown of ventilation practices is presented in Appendix D.

TABLE 14. - National totals for ventilation practices in bituminous-coal and lignite mines, by mine classes and proximity to the coal face

	Class A[1]		Class B[1]		Class C[1]		Class D[1]		All mines	
Ventilation	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent	Number	Per-cent
To face	251	11.6	113	20.9	54	23.9	118	25.5	536	15.7
30 feet of face ..	213	9.7	105	19.4	47	20.8	142	30.8	507	14.9
Last open crosscut	1,620	74.1	320	59.3	125	55.3	201	43.5	2,266	66.4
Natural	99	4.5	1	0.2	0	0.0	0	0.0	100	2.9
Auxiliary fans ...	2	0.1	1	0.2	0	0.0	1	0.2	4	0.1
	2,185	100.0	540	100.0	226	100.0	462	100.0	3,413	100.0

1/ Mine classes: A = 1-14 men underground, B = 15-49, C = 50-99, D = 100 or more.

In most mines the air was not carried directly to the face; 66 percent of all mines carried the air no farther than the last crosscut. The remaining mines were divided about equally between those carrying the air within not more than 30 feet of the face and those carrying the air directly to the face. More of the larger mines carried air to the faces than smaller mines. The use of blower fans for auxiliary ventilation was restricted to a few class A and B mines in Pennsylvania and class A and D mines in Virginia.

Wetting Agents

Not many installations were reported in which wetting agents were used. Seventeen mines used wetting agents, and the majority of these added it to spray water at underground dumps or in the tipple, and these sprays were reported to be very effective in preventing clouds of airborne dust from forming. Only 4 mines used wetting agents on face equipment - 3 on continuous-type mining machines and 1 on a conventional loading machine.

Wetting agents added to water lower the interfacial tension and allow the water to spread on the surface of the coal particles being sprayed. Once these particles are wetted, they adhere to larger pieces of coal and are prevented from becoming airborne. Water with a wetting agent will therefore wet more coal with less water, because the water will spread evenly over the coal surfaces and not lie in puddles on top of a mass of dry coal.

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Employment of Dust-Control Engineers and Surveys of Airborne Dust

Dust-control engineers were employed in 21 mines; 5 of these mines were in southern West Virginia, 5 in Kentucky, 6 in Alabama, 2 in Colorado, and 1 each in Illinois, Pennsylvania, and Oklahoma. All these men were employed in class D mines, except for one class B mine in Kentucky. Dust surveys have been made in virtually all the mines employing dust-control engineers, and six additional mines had surveys made but did not employ engineers for that purpose.

These surveys probably were made by consultants, the Bureau of Mines, or other governmental agencies.

CONCLUSIONS

Results of the survey indicated that the larger mines seemed the most dust-conscious, whereas most of the smaller mines appeared to pay little or no attention to the dust problem or to have concluded, in the case of wet mines, that no such problem could exist.

Water was the chief agent used to prevent the dissemination of dust and in efforts to allay dust that had become airborne. Water was not always entirely effective in controlling the dust produced in the various operations on which it was used but usually had some beneficial results. Few mines added wetting agents to the water. Dry dust collectors were employed mainly in connection with roof drilling for roof bolting. The deeper, drier mines present the greater problems in respect to dust, and it was in these mines that the greatest use of control measures was found.

The survey showed clearly that, even though much had been done by a considerable segment of the coal-mining industry to prevent the formation of high concentrations of airborne dust, a great deal remained to be done in this direction. The need for more and better control measures was obvious. More study should be devoted to effective application of water as a suppressive measure, the design, location, and efficiency of spray nozzles, and the coursing of ventilation through areas where dust is generated. It is believed also that manufacturers of mining equipment should consider means for dust control as a necessary and integral part of the design of the equipment.

Better application of the existing systems for dust control also was a need, as the survey showed that the controls used were, on the whole, effective in only about 50 percent of the applications, as judged by visual observation of dust dissemination. Programs for controlling dust will be effective only if all concerned are dust-conscious, from top management down through the ranks, so that all efforts are coordinated to accomplish the desired and necessary results. Realization of the fact that inhalation of high concentrations of any airborne mine dust is likely to be harmful is bringing about increased use of dust-control measures, which may be expected to offset their cost by improved health and safety of employees, greater efficiency, and better labor-management relations.

The survey showed that the necessity for dust control is being recognized in the coal-mining industry but that improved measures of suppression are needed in many instances and that the problem should be attacked in broader scope.

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APPENDIX

A: List of States according to daily production at time of survey

State	Daily tonnage
1. West Virginia	526,482
2. Pennsylvania	317,000
3. Kentucky	226,214
4. Illinois	156,788
5. Virginia	80,471
6. Alabama	69,023
7. Ohio	60,536
8. Tennessee	37,569
9. Utah	29,767
10. Indiana	27,988
11. Colorado	19,541
12. Group I	17,586
13. Group II	7,748
Total	1,576,713

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B: List of States covered by survey, showing total number of mines, total employment, and daily production in each size class

State	Class 1/	Mines	Employment	Daily tonnage	State	Class 1/	Mines	Employment	Daily tonnage
West Virginia (Northern)	A	171	1,346	9,737	Ohio	A	166	1,152	6,661
	B	79	2,096	24,410		B	27	678	4,950
	C	18	1,202	14,460		C	4	269	2,215
	D	27	7,018	96,539		D	16	4,062	46,710
	Total	295	11,662	145,146		Total	213	6,161	60,536
West Virginia (Southern)	A	39	313	2,657	Tennessee	A	305	1,713	7,692
	B	76	2,322	24,084		B	15	393	3,220
	C	61	4,607	55,590		C	13	933	9,325
	D	148	35,355	299,005		D	17	2,806	17,332
	Total	324	42,597	381,336		Total	350	5,845	37,569
Pennsylvania	A	280	1,821	11,241	Utah	A	20	128	2,617
	B	103	2,742	19,448		B	4	86	1,650
	C	31	2,332	20,128		C	7	541	7,150
	D	95	34,825	266,183		D	7	1,857	18,350
	Total	509	41,720	317,000		Total	38	2,612	29,767
Kentucky	A	416	2,803	20,511	Indiana	A	13	114	973
	B	114	3,160	29,565		B	4	110	1,405
	C	49	3,345	36,605		C	2	116	1,481
	D	62	13,955	139,533		D	8	1,725	24,129
	Total	641	23,263	226,214		Total	27	2,065	27,988
Illinois	A	15	160	1,540	Colorado	A	103	383	2,472
	B	11	314	2,925		B	17	424	4,689
	C	4	272	4,400		C	6	447	4,730
	D	30	8,710	147,923		D	4	1,242	7,650
	Total	60	9,456	156,788		Total	130	2,496	19,541
Virginia	A	298	2,362	18,828	Group I	A	26	114	608
	B	44	1,124	10,225		B	12	356	2,637
	C	12	789	7,428		C	9	694	4,466
	D	22	5,607	43,990		D	8	1,308	9,875
	Total	376	9,882	80,471		Total	55	2,472	17,586
Alabama	A	178	1,032	6,043	Group II	A	153	857	3,777
	B	14	361	3,055		B	20	521	2,705
	C	8	553	3,340		C	2	147	1,266
	D	18	5,196	56,585		D	-	-	-
	Total	218	7,142	69,023		Total	175	1,525	7,748

1/ Mine classes: A = 1-14 men underground, B = 15-49, C = 50-99, D = 100 or more.

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C: Roof-bolting practices. Roof bolting by State production, showing number of mines according to employment groups and percentage of coal produced from roof-bolted areas

State	Mines		Extent of roof-bolting practices						State	Mines		Extent of roof-bolting practices					
	Class 1/	Number	Total mines bolting	Spot bolting	Experimental bolting	Production from roof-bolted areas, percent 0-49	50-99	100		Class 1/	Number	Total mines bolting	Spot bolting	Experimental bolting	Production from roof-bolted areas, percent 0-49	50-99	100
West Virginia (Northern)	A	171	-	-	-	-	-	-	Tennessee	A	307	1	-	-	-	-	1
	B	79	11	-	3	-	-	8		B	15	1	-	1	-	-	-
	C	18	5	-	-	2	-	3		C	13	7	-	2	-	3	2
	D	27	17	-	-	4	6	7		D	17	1	-	-	-	1	-
West Virginia (Southern)	A	39	-	-	-	-	-	-	Utah	A	20	1	-	-	-	1	-
	B	76	8	3	-	2	-	3		B	4	-	-	-	-	-	-
	C	61	19	3	-	6	3	7		C	7	3	1	1	-	-	1
	D	148	76	11	1	22	23	19		D	7	5	1	-	1	2	1
Pennsylvania	A	280	1	-	1	-	-	-	Indiana	A	13	1	-	1	-	-	-
	B	103	4	2	1	-	1	-		B	4	1	1	-	-	-	-
	C	31	5	-	-	1	3	1		C	2	2	1	-	-	-	1
	D	95	46	1	4	16	18	7		D	8	7	1	-	1	2	3
Kentucky	A	416	1	-	-	-	-	1	Colorado	A	103						
	B	114	13	3	-	1	1	8		B	17						
	C	49	12	6	1	3	-	2		C	6			NONE			
	D	62	39	11	3	13	3	9		D	4						
Illinois	A	15	2	1	-	1	-	-	Group I	A	26	-	-	-	-	-	-
	B	11	2	-	-	-	-	2		B	12	-	-	-	-	-	-
	C	4	3	-	-	-	1	2		C	9	2	1	-	-	-	1
	D	30	18	4	-	4	5	5		D	8	2	-	-	2	-	-
Virginia	A	298	-	-	-	-	-	-	Group II	A	153	1	-	1	-	-	-
	B	44	4	2	-	-	-	2		B	20	-	-	-	-	-	-
	C	12	4	-	-	-	3	1		C	2	2	1	-	-	1	-
	D	22	15	5	2	5	1	2		D	-	-	-	-	-	-	-
Alabama	A	178	2	1	-	1	-	-	National total	A	2,185	13	2	4	2	3	2
	B	14	2	-	-	-	-	2		B	540	46	11	5	3	2	25
	C	8	2	1	-	-	1	-		C	226	66	14	4	12	15	21
	D	18	13	-	-	6	2	5		D	462	245	34	11	77	65	58
Ohio	A	166	3	-	1	-	2	-		Total	3,413	370	61	24	94	85	106
	B	27	-	-	-	-	-	-									
	C	4	-	-	-	-	-	-									
	D	16	6	-	1	3	2	-									

1/ Mine classes: A = 1-14 men underground, B = 15-49, C = 50-99, D = 100 or more.

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D: Ventilation practices

State	Mines		Ventilation carried to-			Natural ventilation	State	Mines		Ventilation carried to-			Natural ventilation
	Class[1]	Number	Face	30 feet of face	Last crosscut			Class[1]	Number	Face	30 feet of face	Last crosscut	
West Virginia (Northern)	A	171	13	35	123	-	Tennessee	A	307	-	22	271	14
	B	79	7	15	57	-		B	15	-	4	10	1
	C	18	3	3	12	-		C	13	-	-	13	-
	D	27	9	6	12	-		D	17	-	6	11	-
West Virginia (Southern)	A	39	8	16	15	-	Utah	A	20	1	17	1	1
	B	76	32	16	28	-		B	4	-	3	1	-
	C	61	32	3	26	-		C	7	-	7	-	-
	D	148	65	38	45	-		D	7	-	7	-	-
Pennsylvania	A	280	27	14	210	28	Indiana	A	13	-	4	9	-
	B	103	28	29	45	-		B	4	-	-	4	-
	C	31	2	16	13	-		C	2	-	-	2	-
	D	95	14	54	27	-		D	8	-	-	8	-
Kentucky	A	416	2	12	377	25	Colorado	A	103	47	21	23	2
	B	114	3	4	107	-		B	17	9	6	2	-
	C	49	3	3	43	-		C	6	2	4	-	-
	D	62	7	10	45	-		D	4	4	-	-	-
Illinois	A	15	-	-	15	-	Group I	A	26	14	8	4	-
	B	11	-	1	10	-		B	12	5	7	-	-
	C	4	-	-	4	-		C	9	6	3	-	-
	D	30	2	3	25	-		D	8	4	4	-	-
Virginia	A	298	2	3	290	2	Group II	A	153	47	35	67	4
	B	44	6	1	37	-		B	20	12	7	1	-
	C	12	3	3	6	-		C	2	2	-	-	-
	D	22	4	4	13	-		D	-	-	-	-	-
Alabama	A	178	74	23	61	20	National total	A	2,185	241	213	162	99
	B	14	4	10	-	-		B	540	113	105	320	1
	C	8	1	5	2	-		C	226	54	47	125	-
	D	18	8	9	1	-		D	462	118	142	201	-
Ohio	A	166	6	3	154	3							
	B	27	7	2	18	-							
	C	4	-	-	4	-							
	D	16	1	1	14	-							

Note: Auxiliary fans are used in 2 mines (class A and B) in Pennsylvania; 2 mines (class A and D) in Virginia.

1/ Mine classes: A = 1-14 men underground, B = 15-49, C = 50-99, D = 100 or more.

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E: Questionnaire used in survey

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

SURVEY OF DUST-CONTROL PRACTICES
IN THE COAL MINING INDUSTRY

Inspector's name _____ Date _____

Name of mine and operating company _____

_____

Location of mine--
State _____ County _____ Town _____

Number of men employed--
Underground _____

Surface (tipple and cleaning plants only) _____

Number of shifts per day _____

Average production, tons per day _____

Coal bed, name and height in inches _____

In the following questions on operations, the intent is to obtain information on type of operation and equipment, whether or not dust-control measures are provided, whether they appear effective, and in all cases whether visible dust is evident in the working area of the men engaged in the operation. Check marks, or YES or NO, will suffice to answer many of the questions.

DRILLING

	Coal face	Roof	Bottom	Draw slate
Rotary?	_____	_____	_____	_____
Percussion?	_____	_____	_____	_____
Wet?	_____	_____	_____	_____

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DRILLING (con.)

	Coal face	Roof	Bottom	Draw slate
Dry?	_____	_____	_____	_____
Dust-collector?	_____	_____	_____	_____
Visible dust?	_____	_____	_____	_____

To what extent is roof bolting practiced? _____

_____

_____

COAL CUTTING

	Bottom	Top	Shear
Water on cutterbar?	_____	_____	_____
Sprays?	_____	_____	_____
Jets?	_____	_____	_____
Other?	_____	_____	_____
During sumping in?	_____	_____	_____
Visible dust?	_____	_____	_____

BLASTING

On shift or off shift? _____

By shotfirers or by other workmen? _____

	Conventional permissible	Airdox	Cardox	Chemecol	Other
Place wet before blasting?	_____	_____	_____	_____	_____
Place ventilated before men return?	_____	_____	_____	_____	_____

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BLASTING (con.)

	Conventional permissible	Airdox	Cardox	Chemecol	Other
Material wetted after blasting ?	_____	_____	_____	_____	_____
Visible dust and smoke when men return?	_____	_____	_____	_____	_____

LOADING

	Hand	Mechanical	Type or make of loader, if mechanical
Material wetted before or while loading	_____	_____	_____
Visible dust?	_____	_____	_____

CONTINUOUS MINING-TYPE MACHINES

No dust control? _____

Dust control by ventilation? _____

Brattice to face? _____

Dust control by wetting? _____

Visible dust? _____

Describe dust control method briefly. _____

_____

_____

_____

_____

_____

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TRANSPORTATION

	Conventional cars	Shuttle car	Conveyor (type)
Coal wetted before or during transportation?	_____	_____	_____
Cars dust-tight?	_____	_____	_____
Cars overloaded?	_____	_____	_____
Dust suppresion at transfer or dumping points?	_____	_____	_____
Visible dust?	_____	_____	_____
If above answer YES, at what points in transport?	_____	_____	_____

HAULAGEWAYS

Are haulageways cleaned up, wetted, or treated with salt, calcium chloride, or other consolidating agent?

_____

_____

VENTILATION

How close to face operation is ventilation carried? _____

_____

WETTING AGENTS

Are wetting agents used underground? _____

If so, in what operations? _____

Brand of wetting agent? _____

Considered effective by management? _____

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TIPPLE AND CLEANING PLANT

Give brief description of dust-control practices, covering dump, screens, crusher, and loading booms, mentioning whether wet methods, exhaust hoods, and dust collectors are used.

At what points is dust visible?

Disposal of settled dust?

DOES COMPANY HAVE DEFINITE PROGRAM FOR DUST CONTROL?

Employ dust-control engineer?

Are surveys of air-borne dust made?

ATTITUDE OF MINERS TOWARD PRACTICE OF DUST CONTROL

Are men cooperative in using dust-control measures provided?

ADDITIONAL REMARKS. Add anything else considered pertinent to the problem of dust control. If any unusual or unique dust-control methods or equipment are in use, describe briefly.

Use additional sheets if necessary.

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